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CHILD DEVELOPMENT



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2101 CONSTITUTION AVENUE
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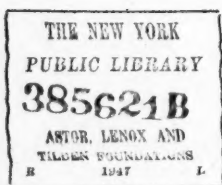
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PHYSIOLOGICAL AGE
THE WORK OF C. WARD CRAMPTON, M.D.

Editorial Note

Some thirty-six years ago Dr. C. Ward Crampton published a paper, "Physiological Age - A Fundamental Principle" in the American Physical Education Review (Vol. XIII, Nos. 3, 4, 5, 6, 1908) containing the results of the work of seven years on this subject. It includes the substance of his earlier reports: "Pubescence," American Anthropologist, Vol. 6, No. 5, 1904, Prize Winning Thesis, Olympic Congress, St. Louis Exposition, 1904, and the "Influence of Physiological Age upon Scholarship," Psychological Clinic, Vol. I, No. 4, June, 1907. It deals in particular with the significance of the different stages of puberty for the physical growth and mental development of children of the same chronological age. Since his investigations may still today have a far-reaching meaning and represent to a certain degree the summary of one phase of his life work, the findings on New York school boys deserve to be recalled. Therefore, it seems to be worth having the paper republished in Child Development all the more because the original is hardly still available to many readers interested in the matter.

In the following pages the original paper is reproduced with only some smaller alterations. The author, realizing that

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few of his readers would be familiar with the new biometric methods, preceded his main paper with a thorough simple presentation of the statistical methods used (*American Physical Education Review*, Vol. XIII, No. 1, 1908, 12 pages).

The findings and computations of the author are given untouched; some of his tables and charts in the appendices are left out to save space - they do not concern the material dealt with in the text proper. In reproducing the charts and tables, the original numbers were retained. Furthermore, it appeared to be reasonable to put ahead of the whole paper the introductory pages of the last section (No. IV) entitled "Significant Features of Life Centering About Puberty," which deal with some of the older literature and give quite an impressive introduction to the problem later discussed in detail by Dr. Crampton.

C.E.P.

PHYSIOLOGICAL AGE - A FUNDAMENTAL PRINCIPLE

C. WARD CRAMPTON, M.D.
New York City

INTRODUCTION: SIGNIFICANT FEATURES OF LIFE CENTERING ABOUT PUBERTY (SECTION IV)

The features of weight, height, strength, and scholarship are the indices of profound physical changes during puberty. An acceleration of growth rate means an upheaval of the whole being. All organs are put under new conditions. It is a significant fact that morbidity increases at this period, though mortality does not. It is unnecessary to go further to emphasize the tremendous significance of the features of this period to the physician. A mere catalogue of some of the changes asserted to take place at this time is pertinent.

Marro (La Puberté) catalogues in girls the pubic and axillary pubescence, development of the breasts and menstruation. (See Chart I, p. 4); also in boys pubic, axillary, and labial pubescence. (Chart II, p. 5.) His series are too small for definite results. He also considers change of voice. (See Chart III, p. 6.)

"At or about puberty" the bones increase rapidly in length and girth.* Moon finds that the legs increase most rapidly in length before puberty, the body afterward. West, Porter, Hrdlička, Peckham, and Smedley found various results on this comparative growth. Throughout the body various bones begin to lengthen and show junction of epiphysis and shaft or body. Ossification is accelerated and completed, but by no means uniformly.

Canine teeth, back premolars and second molars all have their period of change from 11 to 16 years. The lower jaw grows longer and the head changes in many ways.

Before puberty the blood vessels are large and the heart small. The heart increases at this time at a far greater rate than the arteries. This is a most important point and may account for the increase of blood pressures at this stage and for the very characteristic functional affections of the heart. Sexual differences in blood-count become evident at puberty, and anaemias of the chlorotic type are characteristic. The pulse rate is increased during "puberty" (?).

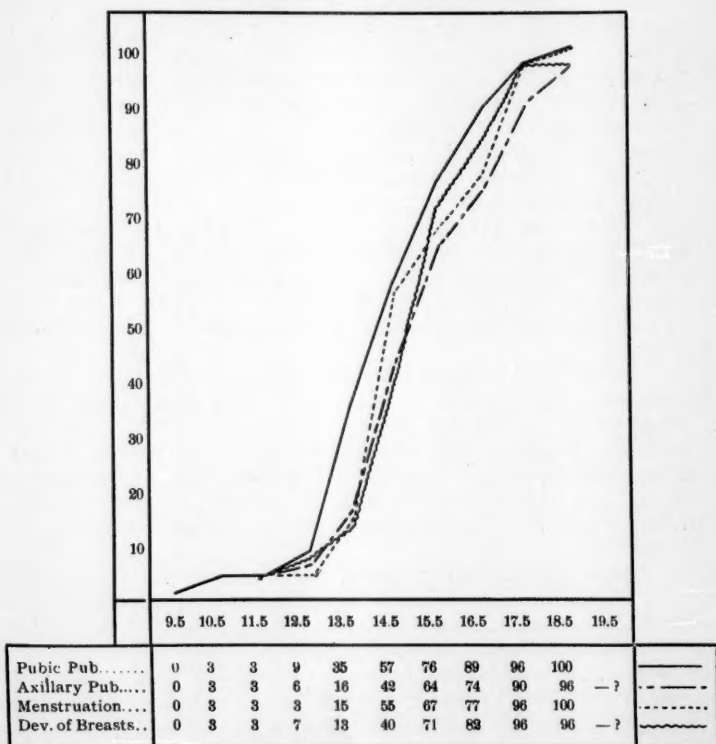
The "capacity" of the lungs is increased rapidly at this

*NOTE. The following data are taken mainly from "Adolescence," G. Stanley Hall.

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CHART I.
PHYSIOLOGICAL AGE. VARIOUS OBJECTIVE SIGNS.
[GIRLS.] ITALIAN.

Plotted from data from *La Pubert , Marro*.



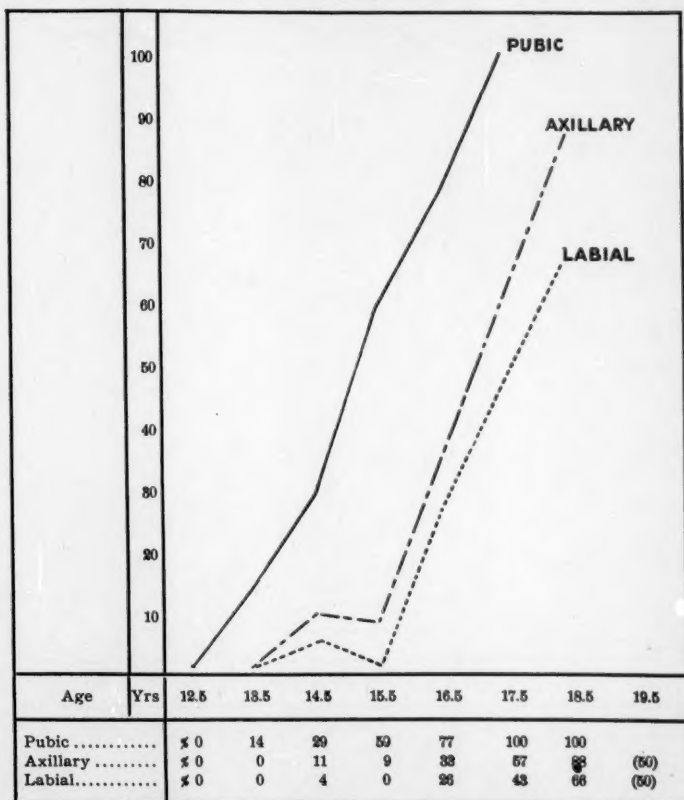
C. WARD CRAMPTON

CHART II.

PHYSIOLOGICAL AGE. PUBESCENCE.

[BOYS.] ITALIAN.

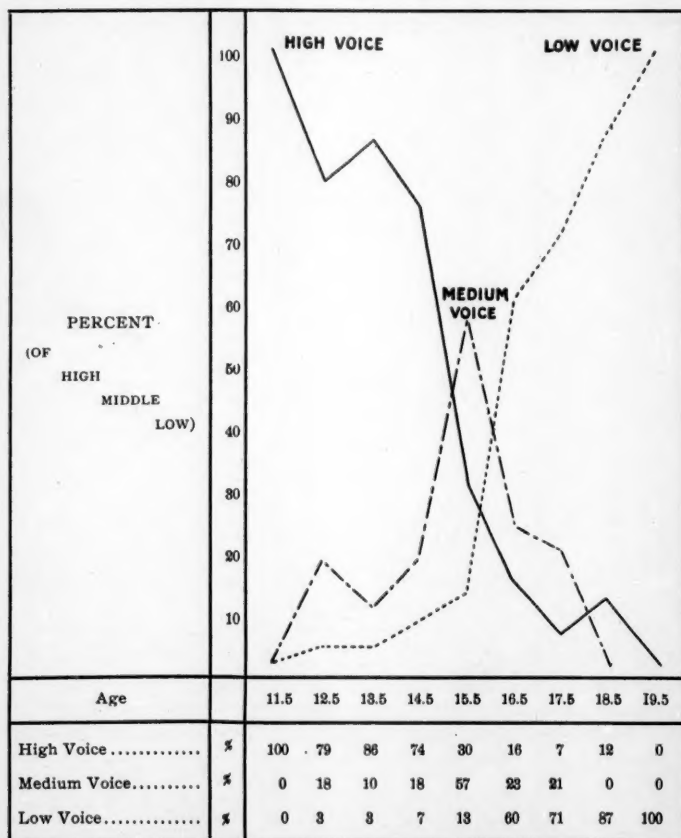
[PUBIC, AXILLARY, LABIAL.]



OBS.—Pubic pubescence corresponds closely to American observations. Irregularity probably due to insufficient data. Percentages calculated from tables given by *Marro*. Italian observations.

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CHART III.
PHYSIOLOGICAL AGE. CHANGE OF VOICE.



OBS.—Irregularity in curves is due to lack of a large number of cases. Plotted from table by *Marro*.

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period. All the internal organs grow rapidly at this time; the kidneys and the liver seem to grow very slowly afterward.

The salivary and the sebaceous glands increase markedly in size and function at this period. Acne and comedones are characteristic. Pigmentation of all colored structures increases, the sexual organs and nipples with their areola become darker.

Boys lose fat, girls often grow thin but soon round out. Stratz classifies his physiological ages on this basis. He schedules "erste Fülle," "erste Streckung," "zweite Fülle," "zweite Streckung," and finally "die Reifung." The transition from the "zweite Streckung," to "die Reifung" possibly corresponds to puberty.

My own observations, confirmed by my assistants, tend to substantiate this. A pre-pubescent has flesh of a tallowy feeling, and his cheeks are rounded, the post-pubescent seems dried out. The skin is not so closely attached to the subcutaneous fat and seems more compact.

Right-handedness and asymmetries occur and become accentuated; right-handedness and scholarship are correlated, according to Smedley.

Hall says: "Puberty is like a new birth. It is the age of reconstruction when new determinants come to the front, and also the point of departure for new development.

"It is the age, too, when, if ever, previous tendencies to abnormality may be overcome both by nature and by treatment. The law of nascent periods or the age curve of growth of each organ or faculty, is one of the first desiderata of genetic psychology; how to apply it, by what means and to what degree to stimulate each part in its stage of most and least rapid growth, and how to apportion training of mind and body - is one of the chief problems of individual pedagogy."

Turning to diseases which are characteristic of the ages of puberty, we find a rich field. Childhood diseases decrease, while rheumatism, disorders of bones, muscles, circulation, etc., increase. Goitre, anaemia, hysteria, epilepsy and a special form of chorea, are stated to be characteristic diseases. "Growing pains" and minor attacks of rheumatism are frequent. It is stated by many authors that the morbidity of the pubescent age is high, while the mortality is low.

Nervous disorders, particularly chorea and stuttering, become marked. Appetite changes, becomes more fastidious, and shows many anomalies.

Functional heart troubles, shortness of breath, palpitation, dyspnoea, languor, feeble pulse and cardiac discomfort, irritability, inertia, sleeplessness, are all cardiac symptoms of the

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pubescent period. Chlorosis and anaemia are notoriously characteristic, and nosebleed is a common symptom.

On the mental side we have a peculiar tendency to morbidity. The birth of the sexual impulse normally causes an upheaval of the whole mental life. Masturbation and other abuses assist in unhinging the weak mind. There are numberless forms of trouble taking their origin at this point. From simple day dreaming to the gravest forms of dementia precox there is a series with countless numbers. Irregularities in conduct, obsessions, cravings, wilfulness, hysteria in all its forms (particularly religious), phobias, blind impulses, sexual perversions are characteristic. It is probable that by far the largest portion of our insane cases begin their trouble at or about this time.

In view of the important features of the period of life under consideration it is particularly important that the study of these features should be adjusted as to developmental periods in contra distinction to age groups.

SECTION I

PHYSIOLOGICAL AGE AND PUBESCENCE DELINEATED

The present investigation was undertaken in the spring of 1901. The problem that arrested my attention at that time was the great and unexplained variability of boys of the high school ages. There were undoubtedly reasons why one boy of 14 years of age was small and another large; one tall and thin, another short; one weak, another strong; one brilliant, another dull.

A series of measurements was undertaken for the purpose of comparing certain physical features of boys who had proved failures in their studies with those who had proved brilliant. This was pursued for a year with the result that no correlation appeared. While taking the records the writer noted that some boys were distinctly pubescent (as to the pubis) while others of the same age were not. This led to the record of this feature, and the findings point to the fact that the whole attitude in respect to the boy at or about the age of puberty must be radically changed. Hitherto there has been no record of the maturity or immaturity of a boy at "the age of puberty." He has been classed "at the age of puberty" regardless of whether there might be years before he would arrive at puberty, or whether he had arrived there years before. There has not hitherto been made a distinction where there is a profound difference. It is almost incredible that we have been so dilatory in this respect; while literature abounds with evidence of the

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general growth rates of boys at the age of puberty, the writer has searched in vain for any data concerning the differential characteristics of the pre-pubescent as distinguished from the post-pubescent.

It is my firm conviction founded upon the evidence herein presented, that all our observations of the young adolescent, whether anthropological, medical, educational, or social must rest upon this definite classification, and not upon indefinite age designations. The attempt to establish an age - in the child labor movement - above which a child may safely work and under which he may not, may well take this fundamental fact into consideration.

It will be my purpose to set forth in this paper the relations of one of the phenomena of puberty with age, growth and growth rates, scholarship, etc., entirely rearranging the data personally obtained upon the basis of signs of puberty, and contrasting these data with those related to the age basis; thereby hoping to demonstrate the need of a complete revolution in our methods of observing and treating the growing boy.

Puberty

Puberty is usually the criterion of designation of one of the periods in almost every one of the multitude of classifications; it is probably the most interesting landmark in all life, for it is the point about which are grouped the most significant and peculiar phenomena of life. Accelerations and retardations in growth rates, asymmetries and anomalies in structure, the disappearance of old, and the budding of new faculties and functions, together with the greatest and most fundamental of all, the change from an asexual to a sexual life, all make puberty worthy of extended and exact study.

Definitions

On account of the general misuse of terms relating to this period, it is well to submit the following definitions:

"Puberty" from pubertas-tatis ("age of manhood") refers to that point of time when the asexual life is changed to the sexual, and the ability to procreate is established. It is not a stage or period of time, but a division line between two periods having no more duration than the division between one year and the next.

From the nature of the case it is practically impossible to determine this moment with exactness. Experimentation is almost wholly precluded. It is only by external and objective signs that we know that puberty is approaching; is about here;

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or is past. All references to the "age of puberty" are inexact in this sense, and the term is far more misleading when it is applied in a general way to any one year which may or may not be indefinitely the average age of puberty.

"Adolescence" from adolesco-ere, evi, adultum, (the "period of ripening") extends from puberty to maturity, and is generally considered to be in the male from 14 to 25 years of age - in the female from 12 to 21. The root verb is an inceptive or inchoative and as such signifies a continued act or process. Hence adolescence is a period of time in which certain events may take place in contradistinction to puberty which is the moment of beginning adolescence. Adolescence begins at puberty and ends with maturity.

"Pubescence" from the inchoative pubesco, ere, evi again denotes a process covering a period of time, the completion of which is often vaguely understood to be puberty. This is a term which is often loosely used to denote puberty, or adolescence. It should be used to mean the process of becoming covered with hair, and unless qualified should have reference to the pubic pubescence alone. A pubescent is an individual who is undergoing this process and is in the period of pubescence. The period of pre-pubescence begins at birth and ends at the beginning of pubescence and all in this period are pre-pubescent. All those who have completed their pubescence are post-pubescent. The transition from the pre-pubescent stage to the pubescent stage is gradual. It is begun by an evident and rapid growth of the fine hair apparently already present. This is readily distinguishable, and this characteristic marks the first part of the period of pubescence; the second period of pubescence commences with the pigmentation of this exaggerated growth and pubescence arbitrarily ends with the appearance of the kink or twist which is definitely characteristic.

This classification of the features of pubescence is, so far as I know, original, at least in its present form. It forms the foundation of this thesis, and will become, it is hoped, the basis upon which all facts referring to pubescence and puberty will be definitely related from this time onward. It is a definite classification and meets the requisition of science - that facts of observation must be of such a nature as to be corroborated by other observers.

There is a very small percentage of error in observation. The three assistants now carrying on this work (the only ones making these observations within the knowledge of the writer) have tallied respectively less than one per cent of variation from each other and from the writer. This shows the classification more definite and less liable to error than estimations

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of eye color or complexion records which were taken at the same time.

PUBESCENCE AS A CHARACTER

It is important that the correlation of age and the pubescence characteristics be stated at the outset. It will be seen that there is a great range of year variation.

Percentage of Pre-Pubescents for Each Half Year

TABLE I.

3885 RECORDS FROM NEW YORK CITY HIGH SCHOOL BOYS.

Age	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75
Per Cent. (81)	60	55	41	26	16	9	5	3	1	0	0	0

From this it will be seen, for example, that as many as 19 per cent of all high school students in the first half of the thirteenth year (the 12.25 group) have left this class of immaturity and it is not until the eighteenth year that all have begun their pubescence. Each half year group save the extreme years of the series shows that its population consists of at least two classes, the pre-pubescents and all others.

The data upon which this paper is based, and all figures given, are from records taken by the writer, or under his immediate direction, from New York City high school boys during the years 1901-1906. The actual percentages, averages, etc., apply to this class of boys only, and probably to this one group alone, for it is hardly possible that this group is exactly duplicated elsewhere. The racial, social and other factors will vary infinitely. The principles laid down from the study of these data are, however, universally applicable.

Data are herein arranged in half year groups, the central point of the half year is used to designate the group. The above and other tables include subsequent measurements of the same individual and should be regarded in that light. In view of the fact that half year groups are used instead of year groups it has not seemed advisable to enter into the labor of calculating the exact average of the ages of all individuals in each half year group as has been advocated by Smedley. (46th Annual Report Board of Education, Chicago.)

The rapidity of this change from the immature group, which we may call the pre-pubescents, is shown well by the steepness of the curve of Chart I, and Table II giving decrease in per cent between each one-half year. The figures under each age are the

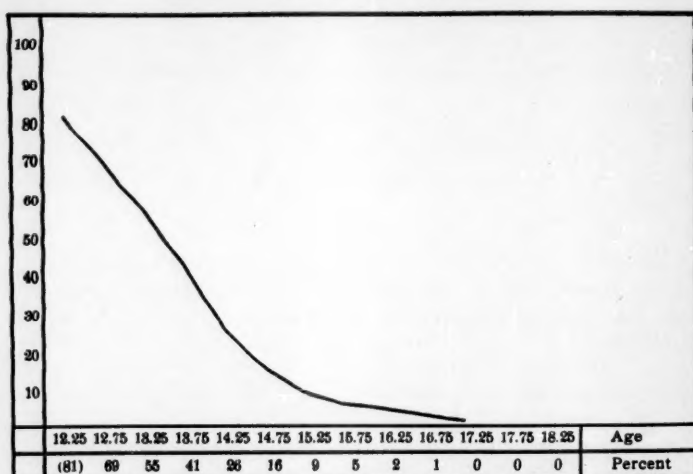
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decrease between that age and the next.

CHART I.

PERCENT OF PRE-PUBESCENTS FOR EACH HALF YEAR.

High School Boys, N. Y. C. (3885 Cases.)



OBS.—This chart shows the rate of disappearance of the immature group.

TABLE II.

Age	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75
Per Cent.	12	14	14	15	10	7	4	3	1	1

The change is most rapid from 13.75 to 14.25. Hence, this is the height of the curve of frequency of beginning pubescence. The other ages immediately preceding this, however, are also popular, and the average date is much earlier than the mean date. For the ending of pre-pubescence and the beginning of pubescence the middle of the mean year is 14.00 years, the average date is 13.44 years with a variability of ± 1.51 years as expressed by the standard deviation. This calculation takes into account the theoretical distribution of the earlier years.

It is hoped that not too much importance will be attached to

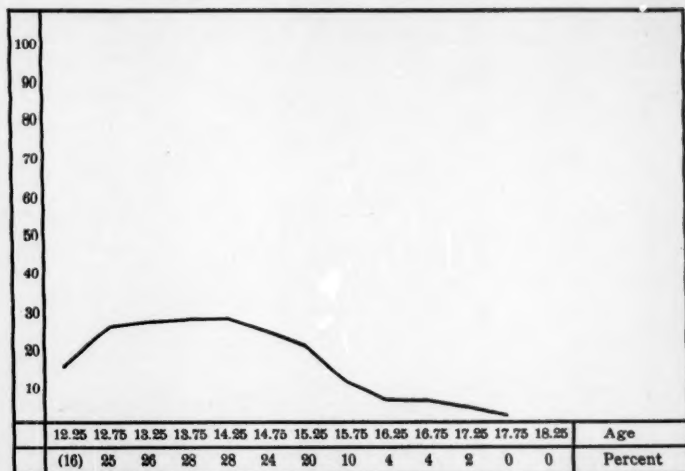
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the average ages of any feature of pubescence, although they may be useful as an incomplete basis for comparison of different racial and social groups. They do not give any information of the characteristics of the population of the age group, which are of prime importance.

CHART II.

PER CENT OF PUBESCENTS FOR EACH HALF YEAR.

High School Boys, N. Y. C. (3835 Cases.)



OBS.—This chart shows the maximum and disappearance of the Pubescent group.

TABLE III.

PERCENTAGE OF PUBESCENTS FOR EACH HALF YEAR.

Age	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75	18.25
Per Cent.	6	25	26	28	28	24	20	10	4	4	2	0	0

See Chart II.

It appears from this table that there are six half years, from 12.5 to 15.5 in which there are 20 per cent or more of the population who are in the stage of pubescence. In no one half year is the per cent of pubescent over 30 per cent. Therefore it is not fair to give to any one year the designation "the year of pubescence" for at any age the large majority are not pubescent.

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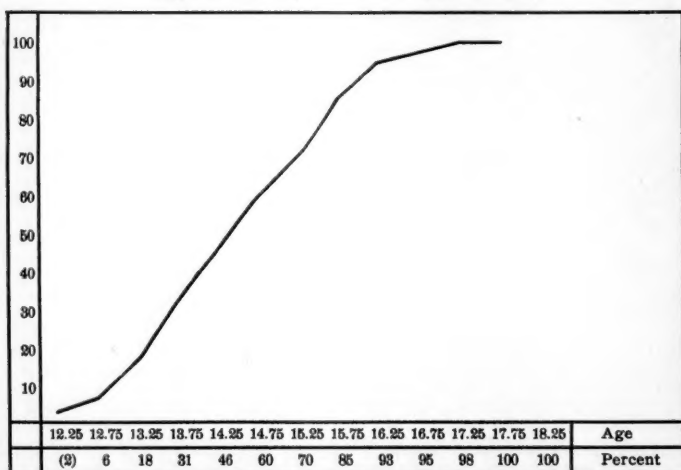
From 13.5 to 14.5, however, our figures show the greatest percentage of any time, and it is evident that this year is the middle of the three in which pubescence usually takes place.

We may treat this table of percentages as frequencies and calculate the middle point. This is 13.90 years with a variability of ± 1.11 years. This age is the middle age of the population of pubescents.

CHART III.

PER CENT OF POST-PUBESCENTS FOR EACH HALF YEAR.

High School Boys, N. Y. C. (3835 Cases.)



OBS.—This chart shows the rate of increase of the mature group.
[Per cent at 12.25 estimated.]

TABLE IV.

PERCENTAGE OF POST-PUBESCENTS FOR EACH HALF YEAR.

Age	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75
Per Cent.	6	18	31	46	60	70	85	93	95	98	100

See Chart III.

The increase in percentage from one-half year to the next is shown on Table V, whereon the rate of increase of the post-pubescent group is given. The difference between each half year and the next is given under the first half year.

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TABLE V.

Year	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75
Per Cent. {	6	12	13	15	14	10	15	8	2	3	2	0
Increase }												

The increment is largest at 13.75 to 14.25 and 15.25 to 15.75. There appears to be a distinct lull at 14.75 to 15.25 which makes the frequency curve bimodal. The younger group is far more extensive, ranging from 12.75 to 14.25, while the mode of the older group at 15.25 is isolated. The average value of this transition from pubescence to post-pubescence is 14.50 years and the variability 1.21 years.

This is as near as we can get to the average age of puberty by this, the so-called generalizing, method (viz. comparing age groups); later, by the study of individuals as such, we can arrive at the same end by a more direct means. This date will be different in every group studied. In Germany it will be nearly a year later, in Norway probably more. If we take a group of children whose parents belong to the upper middle class, the date will be early, in the lower class it will be late. The group studied is 98 per cent American born, but in about 40 per cent both parents were born abroad.

Summary of Percentages

For the sake of clearness, the percentage composition of the age groups studied is assembled and given in Table VI.

TABLE VI.

Half Year {	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75
Age Mean }												
Per Cent. in I.	(81)	69	55	41	26	16	9	5	2	1	0	0
" " II.	(16)	25	26	28	28	24	20	10	4	4	2	0
" " III.	(2)	6	18	31	46	60	70	85	93	95	98	100

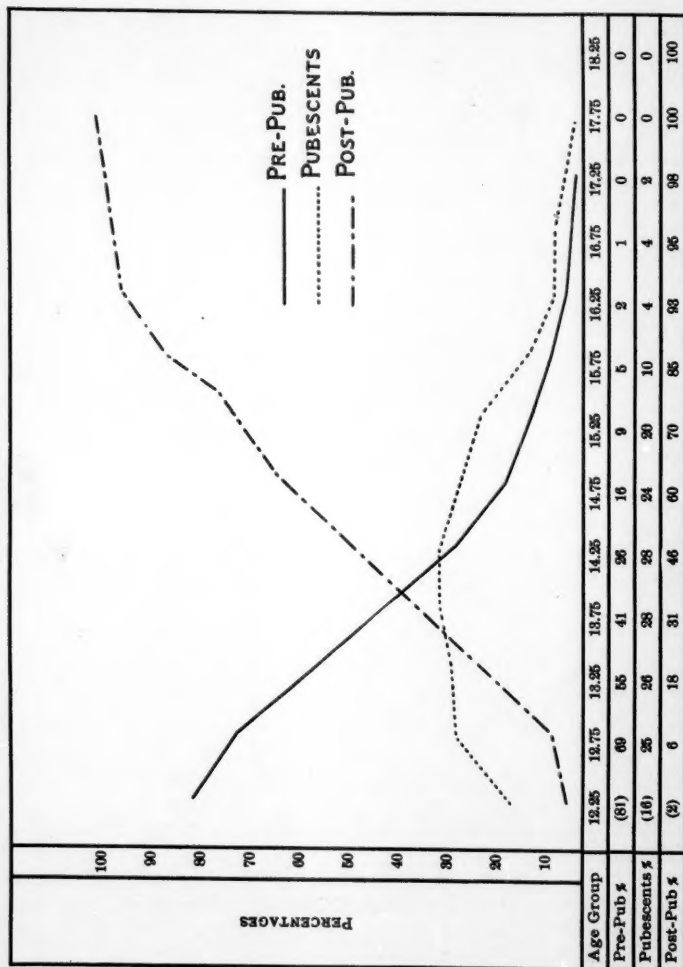
Physiological Age of Pre-Pubescents

We have catalogued the pubescence characteristic of each age group and determined that there is a certain percentage of each pubescence group at each age. The rate of reduction of the immature class has been shown up to the point of its disappearance, but before leaving the subject it is possible to calculate one more important fact concerning the groups.

Referring to the age group 12.75 (12.50 to 12.99), for example, we see that 69 per cent of all are pre-pubescents and that these are destined to become pubescents at varying periods afterward. There is no sign now known by which we can pick

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CHART IV.



Percentage of each Pubescence Sub Group for each Half Year Group.

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out of this group the individuals who are on the verge of pubescence as distinguished from those who will remain several years immature; although we know that 14 of this 69 per cent will change within the next half year and that one per cent will require four years.

This 69 per cent, however, will change at the following rate:

TABLE VII.

Years	
0.0 to .5.....	14
0.5 to 1.0.....	14
1.0 to 1.5.....	15
1.5 to 2.0.....	10
2.0 to 2.5.....	7
2.5 to 3.0.....	4
3.0 to 3.5.....	3
3.5 to 4.0.....	1
4.0 to 4.5.....	1
	<hr/> 69

From this it appears how variable this population really is. Although they are pre-pubescent, some are much younger physiologically than others. For this group of pre-pubescent the average time that will elapse before pubescence is 1.37 years \pm 1.13, while the extreme range is from 0 to 4.5 years. This fact should be borne in mind when any group of pre-pubescent is considered.

In a similar way alternate half years have been calculated as to the average and variability of the duration of pre-pubescence, and the results are given in Table VIII.

TABLE VIII.

AVERAGE EXPECTED DURATION OF PRE-PUBESCENCE.

Half Year Age Group	Years of Average Expectancy	Variability.
11.75	1.88	\pm 1.16
12.75	1.37	1.13
13.75	.97	.77
14.75	.78	.59
15.75	.55	.40

The high school series does not contain any individuals below 12 years. The curve of frequency below this point has been calculated upon the basis of the nature of the rest of the curve. There are thus 93 per cent pre-pubescent at 11.25 (theoretically).

Attention may be called to the table of variabilities. These express the homogeneity of these sub-groups. This is a feature of great importance, for we would expect to find that all char-

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acters which are highly correlated with pubescence would show a similar variability. This variability is a means, although somewhat restricted in function, by which we may explore indirectly for signs of approaching pubescence.

Physiological Age of Post-Pubescents

We may use a similar line of analysis for the post-pubescent group and find out for each age how old they really are in terms of the years elapsing since their entrance into the post-pubescent group. However necessary this may be for determining the characters of a group, it is unnecessary for the individual case, if we have the recorded history of his pubescence. This as yet we seldom have, and it is especially true in our everyday practice, where we meet an individual for the first time. It is to be hoped that the future will correct this, and that all schools will have accurate records for all children under their care.

Another possible method is the observation of the amount of pubic pilosity, the appearance of axillary tufts, hair on the upper lip, etc., although none of these tally with any special date after pubescence.

Taking the half year 17.75, the first half year in which the total observed population is post-pubescent, we find that these 100 per cent have arrived at this stage in accordance with the following table:

TABLE IX.

Time Elapsed Since Puberty Years	Per Cent. Units
0.0 to .5.....	2
0.5 to 1.0.....	3
1.0 to 1.5.....	2
1.5 to 2.0.....	8
2.0 to 2.5.....	15
2.5 to 3.0.....	10
3.0 to 3.5.....	14
3.5 to 4.0.....	15
4.0 to 4.5.....	13
4.5 to 5.0.....	12
*5.0 to 5.5.....	3
5.5 to 6.0.....	2
6.0 to 6.5.....	1
	100

This table shows the exact constituency of the post-pubescent group at 17.75 and demonstrates the high degree of variability. Similar calculations have been made for each alternate half year age from 13.75 to this 17.75. The average and

**NOTE. The figures given for five years and over are theoretical.*

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the variability are given below in tabular form:

TABLE X.

Half Year Age Group	Average Post-pubescent Value—Years	Variability
17.75	8.28	± 1.25
16.75	9.43	1.12
15.75	1.63	.98
14.75	1.13	.73
13.75	.70	.51

This table shows the post-pubescent value of each of the half years given and its variability. On account of the greater variability at the later years, we would expect a greater variability in these groups of all characteristics allied with pubescence. This deduction is borne out by the facts given later in the analysis of the weight-height correlations of pubescence.

"Percentage of Pubescence" at Various Ages

It will assist in clearness if we can designate each age group with a percentage of pubescence. In computing this, the pre-pubescent per cent units are given the value zero, the pubescent one-half, and the post-pubescent one. This gives the pubescents a hypothetical weight and influence of one half the post-pubescents. Where all are pre-pubescents, as for instance at the age of 4 years, the percentage would be zero. Where all are post-pubescents, as at the age of 25 years, the percentage would be 100. The limits of this scale are zero and 100. The group under observation gives the following percentages:

TABLE XI.

Age Mean	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75
Pubescence } Percentage }	(10.0)	18.5	31.9	44.9	59.8	71.6	80.4	89.6	95.3	97.0	99.1	100

By the use of this table we can compare other groups with this standard, and internal sub-groups can be segregated and compared. Even if we have sufficient data in only one year, we can gauge our results on this basis and determine retardation or acceleration of pubescence for the group. In this way we can study the correlation with nationality, social status, complexion, truancy, child labor, weight, strength, scholarship, etc., using any natural or artificial method of forming groups.

It is needless to say that the writer has not had the opportunity to go far into these by-products of the main investigation during the five years spent in elaborating this study. Other and more direct means have been taken to study weight, height,

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strength, and scholarship. During a period of "exploration," however, the writer took records of some 300 high school children of American born parents and compared them with a similar series of children of German parentage, though American born. The results are given in Table XII (see next page).

This shows conclusively that the American born children of German parents are later in their development, a fact that explains a great many features of growth in which this group differs from others. These features are secondary to and dependent upon pubescence, and vary with it. When we have determined the pubescence characteristics of a group, we have largely determined all the accessory features dependent upon it. These facts will become apparent as we proceed.

Summary and Conclusions

The foregoing argument is a study of a sexual characteristic, its appearance, its stages and its final term of completion. This character has sufficient definite objectivity to be used by any one of ordinary powers of observation. It is feasible and reliable. It is an indication of progress from the asexual to the sexual, and the progress from the stage of pubescence to that of post-pubescence marks the dawn of the ability to procreate.*

The rate of decrease of the immature class, the rise and fall of the transition group, and the rapidity of increase of the mature group have been catalogued.

All of these "pubescent ages" contain a mixed population, and emphasis has been laid upon the fact that it is impossible to predicate from the mere fact of age (from 12 to 17 years)

**NOTE. As this statement has a serious medico-legal significance, it is well to state that the evidence upon which it is based rests upon a microscopical examination of the secretion of several cases. These cases came to my notice from an entirely unsolicited source, and occurred in practice, and not in the course of this investigation. I believe that wholesale experiment on this point is to be deprecated. In every case well formed and mobile spermatazoa made their appearance in the months of transition to post-pubescence. This correlation of pubescence and actual puberty rests upon these observations, and the conclusion of coincidence of puberty and the ending of pubescence is warranted. Throughout this thesis this point will not be obtruded; nor is it necessary, for all references will be made to pubescence stages, which are purely objective and admit of absolutely no error. All references to puberty in the male, at least, are inexact unless based upon actual observation or upon the definite relation to pubescence.*

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TABLE XII.
NATIONALITY AND PUBESCENCE.

<i>Parents Born in the United States.</i>			
Age—Year—Mean	13.5	14.5	15.5
Pubescent Stage I.	50%	21%	8%
" " II.	33%	36%	23%
" " III.	17%	43%	69%
Pubescence Percentage	33.5	60.	80.
<i>Parents Born in Germany.</i>			
Age—Year—Mean	13.5	14.5	15.5
Pubescent Stage I.	53%	36%	28%
" " II.	29%	30%	34%
" " III.	18%	33%	48%
Pubescence Percentage	26.5	48.	60.

that an individual is immature, maturing, mature; when he will mature, or how long he has been mature, All designations of sexual characteristics based on age alone are incomplete and misleading.

The variability of the appearance of these characters is great. The total normal range of pubescence, for instance, is about 8 1/2 years and the variability (sigma) is 1 1/2 years. This is so great that we cannot predicate, with even a fair degree of accuracy, the one feature from the other.

The expectancy of pubescence for each year, and the degree of post-pubescence have been calculated. These give definite information as to the characteristics of these pubescent half year sub-groups.

An empirical pubescence percentage for each half year has been set forth, and as an example, the values for children of German and of American parentage have been compared.

SECTION II

THE SIGNIFICANCE OF PHYSIOLOGICAL AGE IN TERMS OF STRUCTURE AND FUNCTION

Various physical measurements of high school boys have been taken, and the pubescence sub-groups for each age have been segregated and serve as bases of mutual comparison. These are weight, height, strength, and scholarship, and will be taken up in that order.

Pubescence and Weight

The weight of each boy was taken (without clothes) and the results are given in Chart V.

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CHART V.
WEIGHT AND PURESCENCE.

[illegible]

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Explanation of Chart. The half year groups include from 12 years and no months up to but not including 12 years 6 months. Pre-pubescence is denominated first stage, pubescence second stage, post-pubescence third stage. These designations will be used hereafter. The numbers given on the chart are the "frequencies" viz., the number of individuals who belong in the age group, pubescence group and weight group designated; thus three characters are considered. Below the number of records in each age pubescence group is its average and its standard deviation.

Observations

(1) From mere inspection it is evident that the total range of each sub-group within a single age does not coincide. At the age group 13.0 to 13.5, group one ranges from 22.5 to 42.5 kilos. Group two from 27.5 to 47.5; group three from 32.5 to 62.5.

(2) The averages for each group show a considerable difference. This difference averages about 10 kilos between group one and group three at each age. This and the foregoing point are proof positive of the utility of the method of sub-grouping, for they both point the fact that the sub-groups have essentially different weight values.

(3) It will be noted that in the whole series there are no pre-pubescent above 55 kilos in weight, and only 4 that are in the 52.5 kilos class, while there are 254 post-pubescent below 16 years who are above 55 kilos in weight. In the 14.25 group there are no pre-pubescent above 45 kilos, while there are 46 per cent of the post-pubescent above that point. Similarly in the same group there are no post-pubescent below 30 kilos in weight, while there are 12 per cent of the pre-pubescent below that point.

(4) At the age 15.75 the post-pubescent are 34 per cent heavier than the pre-pubescent. This is typical and not exceptional.

(5) For the sake of greater accuracy the table above shows measurements grouped in half year groups; but the averages for three whole year groups have been worked out, and are presented below with their standard deviations:

PHYSIOLOGICAL AGE.

Age in Years.	1	2	3	All.	Sigma.
13	34.9	37.7	43.9	37.9	6.96
14	35.7	38.7	46.3	42.	8.19
15	37.5	39.5	48.5	46.5	8.39

(6) It will be noted from this table that the differences

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between the groups one and three at each age are about equal to the difference between the averages (of all) for the years 13 and 15. That is to say, the difference of these groups is about the same as the difference of two years by the old method of grouping.

(7) The difference between the thirteenth year and the fourteenth year pre-pubescent is about 0.8 kilos, while the difference between the first and third group of the age 13 is 9 kilos, or about eleven times as great. From this it is evident that the difference between these two groups of the same age is far greater than the difference between two similar pubescence sub-groups which have a year's difference in age. The pubescence grouping is far "stronger" than the age grouping.

(8) The standard deviation or sigma of each group is given. The sigma is an indication of the variability of the group, and gives to a great extent an idea of its homogeneity. It will be noted that the sigmas of sixteen out of the eighteen sub-groups of the three years 13, 14, 15 are less than the sigma of the including year group, despite the fact that the number of the individuals in each group is smaller, which would naturally cause a greater sigma.

The sigma of the post-pubescent group in each case is much greater than that of the pubescent or pre-pubescent groups. This accords with the findings of our discussion in Section I, where it was shown that the variability of the post-pubescent groups, as to their number of years since pubescence, was considerable, causing this group to be highly variable as to post-pubescence value. The variability of post-pubescence, and the variability of weight of this group move in the same direction and are correlated. This is a secondary proof of the correlation of weight and pubescence shown by the relation to the averages of the pubescent sub-groups. It also leads us to the presumption that the years immediately succeeding pubescence have a high weight growth rate. Actual data on this point will bear out this presumption.

(9) We can infer from this table something as to the character of the growth rates of weight. It will be observed that there is but a small, though constant difference between stage one and two. This would lead us to believe that there is a similar increase in weight in the passage from stage one to stage two. There is uniformly a greater difference between two and three. The average relation of these differences is about as three is to seven. This leads us to presume that growth in weight is more than twice as rapid as that associated with the change from one to two. The actual facts gleaned from the individual treatment of the records of successive measurements

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bears out this presumption, and the results will be given in the discussion on growth rates.

(10) A method of interpolation or assigning age values to weights has been instinctively and erroneously used by the medical profession as well as the laity. A boy's weight is noted, and the scale of average weights is called into play, and on this basis the boy is assigned a certain age value. He is stated to be at the appropriate weight for a certain age. If this age is below that of his own years, he is said to be below weight, and a correspondingly unfavorable impression is registered; if he weighs as much as the average of an older group he is to be correspondingly congratulated. This is somewhat fallacious, for it does not take into consideration pubescence classes. A boy of 13 years may be a heavy pre-pubescent and yet fall below the average of his year, and similarly a boy may be low in the scale of post-pubescents and yet be above the average of his year.

Let us examine the data of one year and show the year values of the three sub-groups, basing the calculation upon the average of the total population for each year:

TABLE XIII.

WEIGHTS OF SUB-CLASSES AND CORRESPONDING YEAR VALUES—AGE GROUP 14.75.

	Weight.	Years Age Value.
Pre-pubescents	36.76	12.75
Pubesents.....	38.86	13.77
Post-pubesents	47.21	15.60

Thus the instinctive method of classification of children on the weight basis is subject to a variation of nearly three years.

Results

Individuals differ from each other in weight according to their maturity. This with similar statements concerning height, strength, etc., is the main thesis, and can be stated in various ways. Each age group of any year from 11 to 18 contains a population that varies in a fundamental characteristic, causing the individual to fall into sub-groups which differ from each other far more than do contiguous age groups. The most important record that we can make of individuals of this epoch is not the age, but the fact of pubescence or non-pubescence, for the physiological age so expressed is far more significant.

In making any observation on the child, we cannot afford to be ignorant of the fundamental feature. The whole of our education has been ignorant of this point for it regards but age in

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years alone. The whole of our medication, in so far as it applies to this period, has never had this scientific foundation; our social organization of this group, in so far as an endeavor has been made by adults to meddle with the automatic self-adjustment of these individuals, has been bungling and inefficient. Where natural groups have been allowed to establish themselves, they remain natural and coherent; where an age basis has been interjected as a means of classification, the result has been chaos.

The whole endeavor of those who are interested in preventing the evils of child labor has been astray up to the present point for the reasons given above. There is no one age when the child is mature enough to work. There is, however, a point of time after pubescence when the growth accelerations are over and cannot be interfered with, that marks the time when the child may undergo the strain of labor with less disastrous results. This may well form the basis of practical legislation which the unscientific age basis alone, cannot.

The Correlation of Height and Pubescence

Height and weight are somewhat related to each other. One is the linear measurement of a thing, while the other is a function of a cubic measurement.

Records of height have been taken from practically the same series of students as were used for weight records. The results are given in Chart VI.

Explanation. These data were first grouped in 5 cm. groups. This was deemed insufficient in definition, and the records were rearranged in 2 cm. groups which are perhaps unnecessarily small, though they are conducive to accuracy. As it was early seen that the number of years after pubescence would affect the group values, it was determined to segregate those individuals who were recorded for the first time as post-pubescents. These are tabulated under 3^1 , all others are put under $3\bar{x}$. There are, of course, some in this class ($3\bar{x}$) whose records were taken for the first time, and it is unknown whether they were in the first half year of post-pubescence or not. The average and its sigma have been worked out for 3^1 alone and for 3^1 and $3\bar{x}$ combined, not $3\bar{x}$ alone for this reason. With the increase of data in the future we will expect to be able to present values for 3^1 , 3^2 , 3^3 , etc., corresponding to the half years past pubescence. At present this is impossible.

The deductions which can be drawn from this work are similar to those drawn from the work on weight. The range of distribution, values, averages, the comparison and flow of the standard deviations all follow the same course, and it is un-

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CHART VI.
HEIGHT AND PUBESCENCE.

Age	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75	18.25	18.75
Pub. Stage	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a
124.0														
126.7														
128.9														
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448.9														
450.7														
452.9														
454.7					</									

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necessary to repeat this line of analysis.

The integrity of the sub-groups and their method of grouping is substantiated and is represented with striking clearness. The actual distribution is frankly given in full so that any investigator may verify the results and use the data for further or different methods of analysis.

As there are several terms' records included in this chart, and pubescence varies as to term, it is advisable to state the term characteristic of the population below:

TABLE XIV.

1st Term.....	2152
2d ".....	953
3d ".....	490
4th ".....	169
5th ".....	55
Total.....	3819

Correlation of Strength and Pubescence

A similar series of records were made of strength of grip of the right hand. This is a peculiarly appropriate test of strength, for according to G. Stanley Hall it has a significance related to the efficiency of the individual in meeting the conditions of arboreal life. Moreover, it follows closely the function of other muscular groups notably of the back and legs, and of "chinning" ability. The two bar dynamometer of the Narraganset Machine Company was used. While the value of the Smedley form is recognized, comparative tests made by me show a smaller variability between the two machines than between successive tests on one individual, hence the usual type was employed chiefly on account of its convenience and durability.

The variability of this test is far greater than either of the others. This is to be expected as it is a test of function and not of structure. Despite this fact, the variabilities are not as high as would be expected under the circumstances.

From an inspection of Chart VII it will be seen that there is a general coincidence with our findings on weight and height.

This proves the validity of our sub-grouping upon a basis of function as well as structure.

It is unnecessary to enter upon a detailed discussion of the importance of the various features of these results. A similar line of analysis to that used upon the weight and height results may be employed.

There is but one important difference, however, and that is the fact that at the ages of 15.75 and 16.25 the pubescent are

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CHART VII.
STRENGTH AND PERSISTENCE.

Year. Half Year.	12		13		14		15		16		17		18	
	18.05	18.75	18.05	18.75	14.05	14.75	13.05	13.75	16.05	16.75	17.05	17.75	18.05	18.75
Pub. Stage	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a	1 2 3 3a
15-19	5		6		6		6		1					
20-24	4	1	40	21	40	21	40	21	10	18	0			
25-29	3	1	38	19	38	19	38	19	16	4	1			
30-34	3	1	36	18	36	18	36	18	18	4	1			
35-39	3	1	34	17	34	17	34	17	18	4	1			
40-44	1	1	1	1	1	1	1	1	1	1	1			
45-49	1	1	1	1	1	1	1	1	1	1	1			
50-54									1	1	1			
55-59									1	1	1			
60-64									1	1	1			
65-69									1	1	1			
70-74									1	1	1			
75-79									1	1	1			
80-84									1	1	1			
85-89									1	1	1			
Number.	11 1 2	46 14 2 2	130 64 16 30	189 136 45 120	145 168 74 210	96 155 90 381	51 111 66 262 31 44 47 275	6 14 31 270	1 7 5 160	3 100	45	58	5	
Average.	(38.14)	(37.6)	(36.1)	(35.7)	(34.8)	(34.3)	(33.5)	(32.8)	(32.1)	(31.5)	(30.8)	(30.2)	(29.5)	(28.8)
Sigma.	13.15	3.85	13.15	4.05	13.15	4.05	13.15	4.05	13.15	4.05	13.15	4.05	13.15	4.05

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weaker than the pre-pubescents. This is unprecedented and points to the conclusion that if pubescence takes place at so late a date as this, it causes a temporary diminution in motor force. (This coincides with the unscientific belief that periods of rapid physiological change are periods of vulnerability.) This is by no means the case for others than this restricted group. It is necessary to follow the individuals themselves through these stages to arrive at positive results.

Herein have been presented three features, two of structure and one of function. We will now turn to the discussion of the complex result of function, success in scholarship.

Scholarship and Pubescence

"Scholarship" is a measure of complex function. It is unlike weight and height, which are purely physical, and is more allied to strength. Success in school life means the ability to get "marks," and satisfy the teacher in daily recitation and upon examinations that the subjects studied are relatively mastered. This scholarship mark is not an evidence of such mental ability as will be surely correlated with after success in life though it may be so correlated. It does, however, stand for the individual's ability to adapt himself to his immediate environment and to win success in his immediate sphere. It is a measure of application, ability and cleverness.

There are two methods that may be used. We may take similar age groups in different grades of the school and demonstrate the average pubescence of these groups which are the same in age while they differ in term. For example, let us take the age group of the half year 14 to 14.50 and estimate the pubescence percentage of each term for this age and state the result below:

TABLE XV.
PUBESCENCE PERCENTAGE AND SCHOLARSHIP.

14.25	
1st Term.....	57.1
2d "	62.7
3d "	69.6
*4th and 5th Terms..	83.3

It is evident that the further advanced the group is in term† (hence in scholarship) the more advanced they are in

*NOTE. See Table XIV for relative size of fourth and fifth term groups.

†NOTE. There are eight terms of one half year each in the high school course.

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physiological age. This fact is strikingly shown by Table XV. The difference between the first term group and the fourth and fifth terms group is 26 per cent units. The group in the highest terms is more than 50 per cent more advanced than the first term group. At 13.25 the group in the third term is 70 per cent, while the group in the first term is only 31.8 per cent, i.e., less than half as much. These percentages have been worked out for the whole series and are given below:

TABLE XVI.
PUBESCENCE PERCENTAGE AND SCHOLARSHIP.

Age.....	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75
1st Term.....	(10.4)	18.8	31.8	42.8	57.1	68.6	76.7	87.3	93.2	97.5	98.0	100.0
2d ".....		(19.0)	30.9	51.5	62.7	72.6	81.4	88.6	95.4	97.2	100.0	100.0
3d ".....			(70.0)	51.2	69.6	78.4	85.9	94.6	98.2	94.9	100.0	100.0
4th-5th Terms				(75.0)	83.3	93.3	89.8	94.1	99.6	100.0	98.0	100.0
All.....	(10.0)	(18.5)	31.9	44.9	59.8	71.6	80.4	89.6	95.3	97.0	99.1	100.

The average movement per term interval in per cent units for each year has been calculated from the above and is given below.

13 Years	+	2.43
14 "	+	8.46
15 "	+	9.32
16 "	+	1.48

If we interpolate in this table the age value for the pubescence percentage as calculated from the average pubescence value of all given on the lowest line, we have the following table of age:

TABLE XVII.

Age.....	13.25	13.75	14.25	14.75	15.25	15.75	16.25
1st Term.....	13.2	13.7	14.2	14.6	15.1	15.6	16.1
2d ".....	13.2	14.0	14.4	14.9	15.3	15.7	16.3
3d ".....	(14.7)	14.0	14.6	15.1	15.5	16.2	16.5
4th-5th Terms		(14.9)	15.4	16.1	15.8	16.2	17.5

It has been calculated from Table XVII that the average movement is plus .4 years.

This is a clear demonstration of the pubescence constituency value in terms of age in years and calculated on the basis of success in scholarship. The higher grade scholars of equal ages are demonstrably older in pubescence to the values given in years.

A second method, and one that is, if possible, somewhat more definite and conclusive than the one just used, is given below. The age groups are divided into pubescence classes and the actual performance in scholarship of each group is recorded. (See next page.)

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TABLE XVIII.*

SCHOLARSHIP—PUBESCENCE—AGE
1ST YEAR HIGH SCHOOL BOYS.

Hours of Failure.	Age and Pubescence Stage.															
	13				14				15				16			
	1	2	3'	3x	1	2	3'	3x	1	2	3'	3x	1	2	3'	3x
0-5	109	63	14	61	63	89	33	150	17	38	24	129	2	2	0	56
5-10	40	19	6	19	31	34	11	56	8	18	6	54	1	2	0	37
10-15	18	10	3	12	18	29	9	32	10	13	12	40	0	0	0	16
15-20	23	13	2	4	22	10	9	21	8	4	3	21	1	1	0	15
20-25	18	8	0	2	7	13	1	11	1	3	1	13	0	3	0	6
Total No.	308	113	25	98	141	184	63	270	39	66	46	257	4	8	0	130
Percent Passing	73	72	75	82	66	67	70	76	64	69	65	71	(75)	(50)	72	62
Percent Failing.	27	28	25	18	34	33	30	24	36	31	35	29	(25)	(50)	28	38

Explanation. Each student has 24 hours of prepared work on which he is marked. He may fail in any number from zero to twenty-four. All who fail in more than 9 hours are not permitted to advance to the next grade, and are hence "failures"; all having nine or less "pass."

It will be observed that 9 per cent, 10 per cent, and 7 per cent more post-pubescents "pass" at the respective ages of 13, 14, and 15 than do the pre-pubescents. Hence, we have corroborated the findings of the previous method.

Summary

Post-pubescents are different from pre-pubescents mentally as well as physically, and the difference is enough to cause us to take it into account whenever we make any observations whatsoever upon mental characteristics of the ages about puberty.

This has never been taken into account when considering boys. Marro has noted the difference in conduct between girls who have menstruated and those who have not. It is fair to state that any investigator disregarding this classification as a fundamental means of grouping the population he studies will find his results subject to a correction of 9 or 10 per cent. This error is enough to vitiate any results whatsoever.

*NOTE. This table will bear extended analysis though only one feature is discussed here. The average failure, sigma, etc., may be calculated and information gained thereby. The distribution of individuals within the passing and failing groups is of great moment, but does not bear upon the central thesis of this paper so much as it does upon constructive pedagogy. Its full discussion may well be reserved.

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While it is not the province of this part of the paper to make application of its results, one definite point bearing upon school work may be mentioned. We must not expect so much in school work from the pre-pubescent or the pubescent as we do from the post-pubescent. The immature groups are obviously less fitted for the strain of high school work. Fifty per cent more of them fail at 13 years than do the mature group. They are held equally blameworthy and without reason. Some adjustment of pedagogical treatment must be made to meet these conditions, for there is a great waste of effort when we try to treat dissimilar students with the same means and expect to get similar results. The immature should be kept in the paternal atmosphere of a special school intermediate between the elementary and high school, and allowed to go to the high school only when he becomes mature enough to meet with relative success under less restricted environment. This would give the immature appropriate educational opportunities, and rid the high school of a great deal of dead timber.

Since there has been a great hue and cry raised about the lack of success of high school students in their studies, and the parallel fact that they leave the high school after a few months or a year, it is apparent that any real fact that explains this failure should meet with earnest consideration.

SECTION III

1. CORRELATION OF PHYSICAL MEASUREMENTS AND SCHOLARSHIP

Scholarship and Weight

We are familiar with the investigations of Porter (Physical Basis of Precocity and Dullness, St. Louis Academy of Sciences, 1893) and of Smedley (46th Annual Report, Board of Education, Chicago, 1899-1900) which showed in children of the same age that weight and school grade were correlated. That is to say, the higher the grade, the greater was the weight. This is undoubtedly true. Smedley selects the most striking case, that of the twelve year group, for detailed presentation. This is given in Table XIX.

This table demonstrates a difference of 8.94 kilos in weight between those of the same age six years apart in scholarship.

Similar results were gained through the whole of the present investigation, but for reasons given below the whole series has not been worked out. For the sake of comparison the re-

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TABLE XIX.

CORRELATION OF WEIGHT, ETC., AND SCHOLARSHIP (SMEDLEY).

Grade	Number	M. M. Average Height	KILOS. Average Weight	KILOS. Average Right Hand Grip
2	4	1333	29.51	16.75
3	19	1377	33.69	20.03
4	84	1403	34.97	20.22
5	134	1422	35.59	21.06
6	143	1443	36.13	21.40
7	95	1451	37.15	22.31
8	18	1443	38.45	23.31

sults for the half year group 14.75 are given.

TABLE XX.

WEIGHT AND TERM. 14.75 YEARS.

Term	Kilos. Weight
1	42.2
2	44.6
3	44.7
4	46.0

This table shows a difference of 3.8 kilos in weight between those of the same age 1 1/2 years apart in scholarship. Theoretically for six years' difference in scholarship, the weight difference would be 15.4 kilos, considerably greater than the difference given by Smedley for six scholarship years' difference at 12 years of age.

These investigations present a fact which is misleading; for it is easy to assume that scholarship and weight are in casual relation to each other. This is not necessarily true, for it will be shown that there is little or no relation whatever between scholarship and weight except in so far as their relation to pubescence relates them to each other. Weight, height, strength, scholarship and all features both physical and mental of the ages about puberty, are effects of many causes. Weight and scholarship are both affected strongly in the same direction by pubescence. Hence they show a positive correlation, but this correlation is in its greatest part only secondary to their primary correlation with pubescence.

There are two ways we can prove this thesis: First, indirectly, we can mathematically determine the influence of pubescence on weight, and observe by trial its coincidence with the similarly determined influence upon scholarship. If these are found equal or their variation determined, the other factors of weight and scholarship respectively become so much the more isolated and subject to analysis. This opens the door to a wide field of investigation. This method is also subject to

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misinterpretation for, even if the calculated movements should coincide, we would not be able to state positively that the coincidence was not accidental and that factors have neutralized each other.

The second method which is emphatically direct is one that will be followed here. We will eliminate pubescence as a factor, and observe directly whether or no there is any correlation other than this.

It will be observed that Porter and Smedley both compared groups of the same age in different terms without regard to the fact that these groups differed widely in their pubescence characteristics. These characteristics have been discovered and shown above. It is well to repeat a portion of the data for the sake of having a concrete example:

TABLE XXI.

WEIGHT—PUBESCENCE—SCHOLARSHIP.
AGE 14.75.

Term	Weight Kilos.	Pubescence Stages			Percentage
		1	2	3	All
1st	42.2	18%	27%	55%	68.6
2d	44.6	15	25	60	72.6
3d	44.7	14	16	70	78.4
4th and 5th	46.0	3	7	89	93.2

This table gives the weight increase with term and the pubescence increase with term together so that they can be readily compared.

We have seen that the post-pubescents weigh more than any other group. Hence, the greater the number of post-pubescents in any group the greater will be the weight of the group. This fact accounts for the results gained by Porter and Smedley.

If the similar pubescence groups of different terms differ from each other in weight, then there is a primary correlation of term and weight. If they do not differ in weight, then there is no primary correlation but a secondary correlation through pubescence. Table XXII enables us to make a comparison and decide this point.

From mere observation of this table it will be seen that there is but little difference between similar pubescence groups of different terms, and that these small differences vary as to direction; some being plus and some minus. In order to ascertain if there is any consistent difference for minus or plus, the differences have been tabulated (regarding only those where there are sufficient data). Thus in 32 cases there is a plus average movement of .08 kilos.

This +.08 kilos average difference between similar age and

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TABLE XXII.

PUBESCENCE—WEIGHT—SCHOLARSHIP.

Age	Pubescence	1st Term	2d Term	3d Term	4th Term
13.25	1	34.02	^o 35.5		
	2	36.46	^o 37.5		
	3	43.39	^o 57.5		
13.75	1	35.09	36.89		
	2	37.92	38.41		
	3	43.14	45.38		
14.25	1	35.38	35.94	36.25	
	2	38.35	39.46	39.50	
	3	45.93	44.51	45.50	
14.75	1	33.46	38.18	35.84	
	2	39.11	38.23	39.72	^o 37.5
	3	45.83	49.54	47.82	46.67
15.25	1	38.15	37.5	^o 39.5	^o 35.
	2	38.5	39.16	^o 40.	^o 37.5
	3	48.14	46.9	49.44	48.50
15.75	1	38.82	37.5	^o 47.5	^o 32.5
	2	40.45	40.31	^o 44.16	^o 62.5
	3	49.12	48.34	50.46	52.83
16.25	1		^o 32.5	^o 37.5	
	2		^o 37.5	^o 37.5	
	3	53.70	50.45	50.14	50.23
16.75	1			^o 35.	
	2				
	3	53.72	53.42	54.17	52.15

physiological age groups which differ only in one term's scholarship is only a small part of the difference between similar age groups which differ in physiological age as well as term. The rest of this difference we can fairly state is due to the hitherto neglected factor, physiological age. The difference between weight averages of similar groups in contiguous terms varies. At 14.75 it is -.17 while the whole difference is 1.26 kilos, which would indicate that the 1.43 kilos difference is due to difference in physiological age. We are warranted in the conclusion that the major part of the apparent correlation of weight and scholarship is due to their respective relations to physiological age. This is obviously only a preliminary step in the analysis of the factors producing the completed result - scholarship.

Scholarship and Height

Similar analysis of height, scholarship, and pubescence stage give similar results as indicated by Table XXIV.*

*NOTE. See original work for author's analysis.

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TABLE XXIV.

PUBESCENCE—HEIGHT—SCHOLARSHIP.

Age	Stage	1st Term	2d Term	3d Term	4th Term
13.75	1	145.8	146.5		
	2	149.9	151.2		
	3	155.4	156.8		
14.25	1	146.0	147.3	149.4	
	2	149.6	149.5	151.8	
	3	156.8	158.1	156.4	
14.75	1	147.3	147.3	147.6	^o 145.
	2	149.9	150.7	151.5	^o 147.
	3	158.0	159.8	159.3	159.9
15.25	1	149.4	148.8	^o 153.	^o 145.
	2	150.7	154.2	151.6	^o 143.
	3	160.3	159.7	162.5	162.2
15.75	1	151.4	^o 145.5	^o 149.	^o 141.
	2	153.2	151.2	^o 157.5	^o 153.
	3	163.4	162.5	162.9	164.3
16.25	3	164.1	165.5	164.9	167.

Scholarship and Strength

A similar analysis has been made of the records of strength of grip (right hand) and term.

TABLE XXVI.

PUBESCENCE—STRENGTH—SCHOLARSHIP.

Age	Pubescence	1st Term	2d Term	3d Term	4th Term
14.25	1	26.72	28.96	26.50	
	2	30.32	30.01	29.38	
	3	36.55	38.02	37.40	
14.75	1	29.16	30.70	28.84	^o 22.5
	2	30.24	30.74	30.00	^o 34.16
	3	38.03	39.49	39.01	39.66
15.25	1	28.89	29.65	^o 35.5	^o 29.16
	2	30.48	33.39	30.56	^o 29.37
	3	38.91	40.04	41.23	41.47
15.75	1	33.33	^o 33.33	^o 27.5	^o 37.5
	2	28.37	30.13	^o 32.5	^o 45.00
	3	41.31	41.65	43.87	45.36

Results

We have seen that scholarship does not bear any marked primary relation to weight, height, strength, etc., though they are all affected in the same direction of pubescence. The only real relations of scholarship are: a probably negative relation

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to weight, a probably positive relation with height, and a possibly positive relation to strength. Their mutual relation with pubescence is the most important feature.*

2. GROWTH RATES

It is customary to state that the period of pubertal growth acceleration in boys extends from 13 to 16 years, in girls from 12 to 14 years. These facts have been gained as a rule from comparison of average measurements of the different years, and are hence subject to many errors. This has been clearly shown by some investigators, and in many cases the actual growth changes in the individuals themselves have been recorded and averaged. These latter results are trustworthy in so far as their information may go.

At the period under consideration, however, it is obviously absurd to assemble growth increments into age groups alone. The boys in any one of our age groups will be passing through different stages of their development. Some will be years past their pubescence, others will live years before beginning their pubescence, others, again, are actually in the period of pubescence. As yet we have not seen any data on growth rates which take this factor into consideration. Wissler (*Growth of Boys*, *Am. Anthropologist*, January, 1903) has demonstrated that the growth rates bear plus correlations to the growth rates of the nearest years, and minus correlations to those more remote.

Our classification must, however, regard the factors of physiological age.

Classification of Growth Periods

For the purpose of this study there are at least seven classes for each year. Those who are in stage one (pre-pubescence) at their first measurement, may remain in stage one, pass to two (pubescence), or all the way to three (post-pubescence), before the second measurement. Those in two may remain there or pass to three. Those in three will forever remain there. Those who were recorded as being for the first time in stage three are separated from those who are unknown as to their past pubescence (owing to the fact that they were in three at the first examination), and those who are known to be more

*AUTHOR'S NOTE. *In elementary schools the author found the contrary correlation, i.e., poor scholarship related to advanced "maturity."* *Ped. Sem.*, June, 1908.

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than one-half year past pubescence. We have, therefore, the following classes:

1 to 1
1 to 2
1 to 3¹
2 to 2
2 to 3¹
3¹ to 3²
3² to 3³

Examinations were made in May and October, making a five-month interval including the summer vacation, and a seven-month interval including the bulk of the school year.

The average increases in weight, height, and strength for winter periods are given in Tables XXVIII, XXX, and XXXII.* The date of the second examination determines the age class.

TABLE XXVIII.
SEVEN MONTHS' WEIGHT INCREASE—PUBESCENCE CLASSES.
1201 RECORDS.

AVERAGES (KILOS.)								
Pubescence Classes, 1st Meas.	1	1	1	2	2	3 ¹	3 ²	3 ³
Pubescence Classes, 2d Meas.	1	2	3	2	3	3 ²	3 ³	3 ³
Ages (12 13 14 15 16 17 18)	0.0	⁰ 1.5						
	1.59	2.23	⁰ 3.5	2.25	2.76	⁰ 3.5	4.25	
	1.66	2.43	4.39	1.91	3.59	3.53	3.70	
	1.58	2.90	4.5	1.78	3.40	3.94	3.10	
	1.5 ⁰		⁰ 3.5	⁰ 2.	4.04	4.03	2.89	
				⁰ 2.5	⁰ 4.	4.25	1.84	
							.81	
Averages, 1.21 2.55 4.44 2.87 3.47 3.94 3.15								

VARIABILITIES.								
Pubescence Classes, 1st Meas.	1	1	1	2	2	3 ¹	3 ²	3 ³
Pubescence Classes, 2d Meas.	1	2	3	2	3	3 ²	3 ³	3 ³
Ages (13 14 15 16 17)	1.23	1.94		.82	1.80			2.33
	1.37	1.37	.90	1.54	2.06	2.44		1.95
	2.07	2.30		1.48	2.20	1.80		1.95
			.00		1.27	1.46		2.36
								1.63

Weight Increase

It will be observed immediately that each pubescence interval class has its characteristic growth rate. These rates vary from each other in some cases 200 per cent.

The growth rate of the pre-pubescent who remain pre-

*NOTE. For similar data on summer, five months' period, see original work of author.

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TABLE XXX.

SEVEN MONTHS' HEIGHT INCREASE—PUBESCENCE CLASSES.
1197 RECORDS.

AVERAGES (Cm.)

Pubescence Classes, 1st Meas.		1	1	1	2	2	3 ¹	3 ^x
Pubescence Classes, 2d Meas.		1	2	3	2	3	3 ²	3 ^x
Ages— (12 13 14 15 16 17 18)	12	⁰ 2.5	⁰ 3.5					
	13	2.68	3.54	⁰ 4.5	2.94	4.23	⁰ 7.	5.29
	14	2.56	3.56	5.5	3.24	5.35	5.24	4.31
	15	2.11	3.21	⁰ 6.5	3.27	4.58	4.70	3.49
	16	⁰ 1.5		5.1	2.5	4.78	4.63	2.85
	17				⁰ 1.5	⁰ 3.5	⁰ 5.	1.65
	18							.87
Averages,		2.45	3.44	⁰ 5.2	2.99	4.73	4.65	3.07

VARIABILITIES.

Pubescence Classes, 1st Meas.		1	1	1	2	2	3 ¹	3 ^x
Pubescence Classes, 2d Meas.		1	2	3	2	3	3 ²	3 ^x
Ages— (13 14 15 16 17 18)	13	.93	1.44		.83	1.40		1.08
	14	.80	1.30	.53	1.39	1.30	1.42	1.44
	15	.49	1.29	⁰ 1.00	.94	1.56	1.57	1.99
	16	⁰ .00		.91	.00	1.09	1.23	1.69
	17							1.44
	18							.69

TABLE XXXII.

SEVEN MONTHS' STRENGTH INCREASE—PUBESCENCE CLASSES.
1134 RECORDS.

AVERAGES (KILOS. GRIP RIGHT HAND).

Pubescence Classes, 1st Meas.		1	1	1	2	2	3 ¹	3 ^x
Pubescence Classes, 2d Meas.		1	2	3	2	3	3 ²	3 ^x
Ages— (13 14 15 16 17 18)	13	2.65	3.38		1.14	4.06		6.43
	14	2.13	3.08	6.95	2.63	6.65	5.50	6.35
	15	1.59	4.69	⁰ 8.16	2.50	5.24	6.70	6.80
	16			⁰ 2.50	3.75	6.55	5.32	6.29
	17							5.64
	18							5.12
Averages,		2.12	3.72	⁰ 5.90	2.50	5.12	5.84	6.02

VARIABILITIES.

Pubescence Classes, 1st Meas.		1	1	1	2	2	3 ¹	3 ^x
Pubescence Classes, 2d Meas.		1	2	3	2	3	3 ²	3 ^x
Ages— (13 14 15 16 17 18)	13	4.55	4.72		5.14	4.45		8.27
	14	4.25	4.46	3.60	4.83	4.98	4.08	6.73
	15	5.57	4.66	⁰ 2.36	5.00	4.99	5.09	5.81
	16			⁰ .00	4.02	3.31	5.22	6.46
	17							6.76
	18							6.09

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pubescents (1 - 1) is the lowest of all; those who are post-pubescent for the first time (3^1 - 3^2) have the highest growth rate. The 1 - 2 class grows faster at each age than the 1 - 1. The 1 - 3 class, cases where the whole stage of pubescence is passed through within the interval of measurement, shows a very high rate (4.44 in seven months). There are very few who develop so rapidly as this, and the data are meagre.

The 2 - 2 class contains those who are the slowest in developing after beginning their pubescence. They show a fair increase in weight, though not so much as those (2 - 3) who finish their pubescence.

Those who are in their first year of post-pubescence, the 3^1 - 3^2 class, show the highest growth rates with practical uniformity throughout the years. The 3_x - 3_x class (composed of those of whom we do not know the time elapsed since puberty) shows a striking and consistent feature. The rate at 13 years is the highest recorded in summer or winter series, each successive year shows a diminution, until at eighteen it is the least of all. The thirteenth year 3_x - 3_x class must of necessity be mainly 3^1 - 3^2 , for there are very few (sixteen per cent) post-pubescent at twelve years, as we have noted in our previous records. The same thing is true of fourteen years to a less degree.

If we refer to our previous discussion of the constitution of this 3_x group as to their number of years post-pubescence, we will see that the greater the average number of years post-pubescence the less the growth rate will be on the tables just given. For instance, the group 13.75 has a value of only .70 years post-pubescence while the winter growth rate of the thirteenth year group is 4.25 kilos. The group 17.75 on the other hand has an average of 3.28 years post-pubescence, and a winter growth rate of 1.84 kilos for seventeen years (.81 kilos for eighteen years). The difference between the 3^1 - 3^2 group and the 3_x - 3_x group at seventeen years is most striking. On these facts we are able to determine a rational growth curve, and understand what we may expect in the way of growth acceleration.

Boys (above 12 years) do not grow, on the average, more than three kilos a year until they begin their pubescence, no matter how late that may be. On beginning pubescence their acceleration commences. It is slow at first; if pubescence is short their rate is very high, if slow the rate is lower. The most rapid rate is attained at and immediately after their transition to the mature stage. The rate gradually declines, reaching a lower point three or four years after pubescence than it had in pre-pubescence.

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There are two results of this portion of the work that must work a radical change in our ideas of growth.

(1) There is no "pre-pubescent acceleration," though the "pre-pubescent acceleration" has been referred to ever and anon. There is perhaps a slight pre-pubertal (1 - 2) acceleration, but it is insignificant in comparison to the pubertal (2 - 3 and 3¹ - 3²) acceleration which continues well into post-pubesence.

(2) Acceleration bears but a slight relation to age. The prime index of acceleration is the physiological period. This is additional proof of our main thesis.

Height

What has been said upon weight may be repeated almost word for word about height. There is the same clean-cut definition of results, with the same dependence upon pubescence. There is evidence, however, that the 1 - 1 and the 1 - 2 groups increase more rapidly in height than they do in weight. Using the most rapidly growing class as a basis for comparison, the 1 - 1 groups grow 22 per cent and the 1 - 2 classes 17 per cent faster in height than weight.

Strength

Our strength increments show some instructive variations from the purely structural measurements.

The main features are the same: acceleration beginning with pubescence, reaching a rapid rate during late pubescence and continuing into post-pubesence. Here we notice a decided difference between summer and winter records. The summer records for group 3_x - 3_x show a decrease from 6.88 kilos at 13 years to .89 kilos at 17 years, and this is in accordance with weight and height records. The winter records, however, show a high rate of increase continued through to the eighteenth year, which is 5.12 kilos, while the summer record for the seventeenth year is .89 kilos. This may possibly be a seasonal variation, and if it is so it is at variance with all our preconceived ideas on the subject. It is probable that this steady winter increase is due to the physical training received in the winter and not continued into the summer.

Again, the slow developing group 2 - 2 shows a very slight summer gain, averaging less than a kilo for five months, while the winter averages are over six times as great. The fast-developing group 1 - 3 shows a similar difference. Here is perhaps an item for a brief for physical training.

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Perhaps it is an evidence of the relaxing nature of heat, perhaps an evidence of seasonal variation of alternate appendicular and somatic function. At any rate, we have a new fact to use as a basis for further exploration.

Rapidity of Development

The rapidity of development, the rate of passage between the several stages and the probability of beginning or ending of pubescence are all features of great importance that have been only indirectly presented in the foregoing discussion.

Table XXXIII gives the comparative rate of change for each age group during a seven-month winter interval.

TABLE XXXIII.

RAPIDITY OF DEVELOPMENT. 7 MONTHS WINTER INTERVAL. 1471 CASES.

		Age	12	13	14	15	16	17	18
Pubescence	1-1		2	47	119	33	4		
	1-2			27	60	50	0		
	1-3 ¹			2	11	0	4		
				76	190	83	8		
	2-2			14	47	26	4	2	
Stage	2-3 ¹			18	61	88	26	4	
Movement				32	108	114	30	6	
	3 ¹ -3 ²				43	69	17	4	
	3 ² -3 ³			23	175	248	181	57	4
NUMBER OF CASES			2	132	516	514	236	67	4

This table gives us the rate of flow of pubescence, and from it we can calculate the probability of length of pubescence, etc. The data are not sufficient to show a smoothness of result throughout, and but a few points are emphasized.

Of those who are in pubescence, at the age of fourteen, 43 per cent remain there during this seven-month interval as against 22 per cent at fifteen and 13 per cent at sixteen years. This is positive evidence in support of the thesis that the later the change the more rapid it is.

A comparison of this table with data from the summer flow (1635 cases) shows that the pubescence change is far more rapid in the summer.

Despite the fact that the winter period is two months longer than the summer, the summer is obviously and markedly the season for rapid development. The whole range of results as to seasonal growth given by Malling-Hansen must be reviewed in the light of these and other foregoing facts.

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TABLE XXXIV.

SUMMER (5 MONTHS) AND WINTER (7 MONTHS).

RAPIDITY OF REMOVAL FROM PUBESCENCE TO POST-PUBESCENCE. PERCENTAGE
OF THOSE PROGRESSING DURING THIS INTERVAL

Ages.	13.	14	15	16	17
Summer—5 Months	75	90	91	87	100
Winter — 7 Months	56	56	77	86	96

Conclusions

(1) Growth rates are dependent upon pubescence periods and not upon age.

(2) Accelerations in weight, height, and strength occur at the same time.

(3) The growth impulse makes itself felt strongly in the early part of pubescence, reaches its climax at or immediately after the change to post-pubescence. It may continue for some short time after the change. This conclusion controverts the usual belief held first by St. Hilliare that growth in weight and growth in height were mutually incompatible. It also refutes the accepted theory that gain in strength does not occur during rapid growth.

(4) The more rapid the development, the more rapid is the gain in weight, height, and strength.

For the purpose of exhibiting the coincidence (or lack of it) between the results of the study of averages and individual cases, the following data of successive examinations of individuals are given.*

TABLE XXXV.

CASE I. H. D. G. Ht. 147.6 Wt. 34.40 (At first examination).

Age	13.7	14.2	14.7	15.2	15.7
Pub. Stage	1	1	1	2	3
Inc. in Ht. Cm.		2.6	2.	3.	4.5
Wt. K.		1.35	0.	3.75	3.75
Str. K.		1.	1.	4.	4.

CASE II. H. D. Ht. 137.2 Wt. 33.55

Age	12.11	13.4	13.11	14.4	14.11	15.4
Pub. Stage	1	1	1	2	3	3
Inc. Ht.		2.	2.6	2.9	4.6	3.4
Wt.		1.7	1.65	3.1	3.5	4.2
Str.		+3	-1.	4.	3.	3.

*NOTE. This was perhaps the first appearance in literature of records of successive growth and development measurements of individuals (vs. group-records) from year to year—so well carried out later by Terman, Scholz, et al.

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CASE III. A. J. F. Ht. 148.0 Wt. 41.7 Str. 32

Age	13.8	14.3	14.8	15.3	15.8
Pub. Stage	1	1	1	3	3
Inc. Ht.		2.	1.7	5.4	4.5
Wt.		.9	.9	4.5	5.3
Str.		-2	-1.	9.	4.

The above cases follow the average results and are somewhat typical.

The following cases show a somewhat continued acceleration which lasts through a year and a half or two years after pubescence.

CASE IV. E. W. Ht. 151.4 Wt. 31.5 Str. 30

Age	13.10	14.5	15.10	15.5	16.10	16.5	17.1
Pub. Stage	2	2	3 ¹	3 ²	3 ³	3 ⁴	3 ⁵
Inc. Ht.		1.8	4.3	4.6	3.2	4.4	1.2
Wt.		4.35	1.9	4.25	2.75	4.55	.7
Str.		4.	4.	5.	2.	10.	0.

This case shows four half years of rapid growth terminated suddenly at 16.10 years.

The following case shows a gradually diminishing acceleration.

CASE V. A. B. Ht. 141.8 Wt. 31.8 Str. 26

Age	14.8	15.1	15.8	16.1	16.8	17.1
Pub. Stage	2	3 ¹	3 ²	3 ³	3 ⁴	3 ⁵
Inc. Ht.		7.4	4.2	3.5	3.1	.8
Wt.		5.3	3.4	2.25	2	1.25
Str.		2	7.	3.	2.	2.

The weight acceleration often continues longer than the height acceleration.

TABLE XXXVI.

CASE VI. R. N. T. Ht. 161.3 Wt. 44.8 Str. 30

Age	14.2	14.9	15.2	15.9	16.2	16.9	17.2
Pub. Stage	2	3	3	3	3	3	3
Inc. Ht.		3.7	3.2	2.3	.3	.8	.4
Wt.		3.6	3.3	1.3	1.75	1.75	2.5
Str.		6.	2.	6.	-1.	4.	1.

In this case the boy was unusually tall at the beginning of the series.

Sometimes there occurs a second acceleration. This seems

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to be oftenest the case when the acceleration occurring at the typical time is weak and abortive. This is shown by Case VII.

TABLE XXXVII.

CASE VII. W. G. Ht. 142. Wt. 29.4 Str. 24

Age	13.0	13.7	14.0	14.7	15.0	15.7	16.0
Pub. Stage	2	2	3	3	3	3	3
Inc. Ht.		2.	3.	3.7	2.3	4.5	3.
Wt.		3.1	1 25	2.3	— .3	5.85	3.
Str.		1.	3.	7.	7.	4.	4.

NOTE. The author is fully aware that errors of observation will account for some of the irregularities shown above. These errors will correct themselves, however, where the measurements are repeated as shown. There is little probability of the height error exceeding .5 cm., the weight 1 k. or the strength 3 kilos.

These cases express in a different way the fact of the dependence of growth accelerations upon pubescence stages.

The character of the acceleration depends somewhat upon many factors other than age and pubescence, for there must be reasons for the irregularities shown in these individual cases and some reasons for the variabilities tabulated. Race, heredity, social, and hygienic condition have to be recorded as influencing growth and the growth acceleration; all those continue to show their influence when pubescence is determined as a factor and eliminated. Scandinavian, Scotch, light-haired Germans are tall races; Italians and French are among the shortest of our group. Children born here of Jewish parentage outstrip their parents, and furthermore it is a general rule that all children of mixed parentage are more like the larger parent in growth.* Younger sons often outstrip older brothers at pubescence, and pass them in actual weight and height, if the difference is less than two years in age. Several instances of this have occurred in this series of cases and are worthy of special report. The upper middle social stratum is most favorable for large growth. The upper middle hygienic stratum appears also to be the most favorable. The very poor and vicious often accelerate early and incompletely, passing for the nonce those in more favorable circumstances; this is probably due to early exposure and sex influences.

(The author continues with an analysis of correlation of tooth eruption with physical measurements, a table on correlation on weight, height, and menstruation, an assembly of physiological age signs throughout life and the following statement.)

*NOTE. See Roas and Crampton, Report of Federal Immigration Commission.

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CONCLUSION

The writer has attacked the general problem of the significance of physiological age in three studies. One, the first, is finished as regards the central thesis; the other two are but sketched. By-products of these theses are too numerous ever to reach a stage of completion. In fact, the importance attached to this work rests upon the far-reaching - nay, universal application of this theme. There is no biological or humanistic endeavor which will not be affected by this change of base.

In closing, the writer may well repeat the words of his previous remarks: "It is my firm conviction, founded upon the evidence herein presented, that all of our observations of the young adolescent, whether they be anthropological, medical, educational, or social, must rest upon this definite classification."

THE WORK OF C. WARD CRAMPTON, M.D.
PHYSIOLOGICAL AGE
(to February, 1944)

Pubescence. *Am. Anthropol.*, Oct. - Dec., 1904.

The influence of physiological age upon scholarship. *Physiol. Clin.*, June, 1907.

Statistical methods (used in the Physiological Age Study). *Am. Phys. Educ. Rev.*, Jan., 1908.

Physiological age - A fundamental principle. *Am. Phys. Educ. Rev.*, March, April, May, June, 1908.

Anatomical or physiological age versus chronological age. *Pediatrics*, June, 1908.

Anatomical or physiological age versus chronological age. *Pedagog. Sem.*, June, 1908. (Reprinted from *Pedagog. Sem.* as Bull. 1 on Physiological age, etc., by the Committee on Physical Welfare of School Children, New York City.)

The differences between anatomic, physiological, psychological, and chronological age as causes of derailment. *Am. J. Obstet. and Dis. Women and Children*, 1910; *Proc. Nat. Assn. for the Study and Educ. of Except. Children*.

The significance to the physician of physiological age. *Am. J. Obstet. and Dis. Women and Children*, 1912.

The significance of physiological age in education. Reprinted from *Trans. 15th Internat. Cong. on Hyg. and Demography*, 1913.

Physiological age and the school. *J. Genet. Psychol.*, June, 1930.

Why don't I grow? *Parents' Mag.*, Aug., 1938.

(With E. De Alton Partridge, Ph. D., joint author): Social adjustments associated with individual differences among adolescent boys. *J. Educ. Sociol.*, October, 1938.

Quotation from "Significance of Physiological Age in Education" (Crampton), *Transactions of the Fifteenth International Congress on Hygiene and Demography*, 1913, Government Printing Office:

"The particular periods when instincts appear have (in small part) been noted, and appropriate instruction has in the

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main been provided, but the great failure of education today is its inability to recognize the fact (where it is absolutely essential that it should) that children differ in rapidity of development. Its maladjustments are particularly evident and distressing at or about the time of puberty. The change from an asexual to a sexual life may occur at any age from 6 to 20 years, usually between 12 and 15, but when it does occur, the changes are profound. In the short space of six months the child becomes a man or a woman, and the process is fraught with the dangers and turmoil of a new birth. There is an outburst of physical growth, 4 to 5 inches are added to height, 30 to 40 pounds to weight, and strength may be doubled in a short space of time. New mental abilities appear, while others disappear, the type of play changes, new companions are sought, new likings, tendencies, enthusiasms, and emotions make up the whole life. Old landmarks of life fade and new ones are eagerly sought.

"The sexual ripening determines an entirely new outlook upon life, the earning instinct looms large in the boy, and the home-making instinct in the girl.

"The important fact that is constantly disregarded is the fact that the pubertal change leaves the child a wholly different being - different mentally, physically, morally, and ethically from the children in the stage just left behind.

"This disregard results in the endeavor to teach classes that are composed of children of both prepubertal and postpubertal stages, the immature and the mature.

"Sitting alongside of each other, receiving the same teaching, subject to the same regulations and discipline, are children three or more years past puberty, and others three or more years lacking before the change will occur. The result is chaos. No one course of study can be fitted to their disparate needs, and no one form of discipline can be enforced with each group with equal success.

"This condition obtains in the whole of the grammar department of the elementary school, and in the first year of the high schools. It is particularly troublesome near the point of articulation of the two schools.

"The elementary school commences theoretically at or about the age of 6, when the child is able to go to and from school, and has become a burden at home, which the head of the home, the mother, can and should shift in part to the shoulders of the public. The lower school has for its opportunity the years up to the time when the child reaches its pubertal age. This is between the age (on an average) of 13 or 14; hence, allowing for slow progress, there will be about 7 or 8 years for the elementary school. From ages of experiment, it has

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been found that the child will not study in school after this epoch has been reached unless undue compulsion has been used. The elementary school is naturally self-limited by the advent of puberty. The post-pubescent child is often kept in the elementary school by force of will and authority, and what is worse, he is subjected to the same treatment as the immature child."

1. Examples of adaption of principle studied, National Education Association, July, 1911: "A child's actual age should be determined by physio-psychological data."

2. The American Medical Association report on Committee on Medical Inspection recommends: "As far as practical, the grouping of children should be in accordance with developmental age."

3. The High School of Commerce arranged 8 sections of entering class from physiological age standpoint. The rate discharged from school was 35 per cent less than in the controlled group and 33 per cent less than the previous entering class."

4. Elementary Schools: 114 classes in 7th and 8th years in 7 schools were upon a physiological age basis. For example: 7A had most immature; 7AB, intermediate group; 7A3, most immature.

(A new plan of quickly and conveniently estimating physiological age was devised by the author, approximating the pubescence classification. It was based on observed correlations. A class of 40 can be examined by the author in 15 minutes, and assigned to physiological age groups. Teachers used the same method after brief instruction.)

"The boys formed a line and passed in review, each stating his age to the examiner. He was then given a number - one was most mature, five the least. The following signs were noted: The voice (changed and low or unchanged and high); the presence of the second molars; height and weight; the subcutaneous fat of the face and hands. In the immature the subcutaneous fat is more evident and adheres closely to the skin, which is of finer texture; in the mature the skin is firmer and thicker, less attached to subcutaneous tissues, which contain less fat. The prepubescent is chubby, the postpubescent may be fat, but there is an easily recognizable difference. This inspection is frankly different from the examination for pubescence, and the resulting classification may or may not differ from a division on the basis of that sign. It stands as a separate, but allied, experiment, and its results are regarded accordingly."

The following schedule is from the author's Fifth Annual Report as Director of Physical Training in the New York Public Schools, 1913. The opinion of the class teachers is as follows:

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		Doubtful or no Change	No
	Yes		
1. Is there a more unified class consciousness?	107	1	6
2. If so, is this profitable to discipline?	93	3	17
3. If so, is this profitable to scholarship?	92	2	13
4. Is discipline harder?	25	19	65
5. Are the mature slower?	86	6	13
6. Are the immature "brighter"?	93	3	12
7. Do the mature work better segregated?	65	15	28
8. Do the immature work better segregated?	91	15	3
9. Is the approach to a subject different for immature and mature?	103	1	7
10. Are different methods indicated?	90	1	12
11. Do you think it worth while to make this grouping? .	88	3	21
12. Comment.			

"The practical application of this doctrine will result in the removal of the immature from the high school, where they do not belong, and where their scholarship is poorer than the mature. They may be kept in a ninth year added to the elementary school. This will leave the high school to the mature alone.

"The mature should be removed from the elementary school and placed in subgrades added to the high school, or in an intermediate school, where their young adult possibilities may be fostered and find unimpeded development." (1944. Since this was written, the Junior High School has been developed. It helps somewhat. Author.)

SUMMARY

"There are in childhood and adolescence easily distinguishable epochs of development.

"Children of the same age but in different epochs may differ from each other 50 per cent in degree in certain characters and wholly in kind in certain other characters.

"There are certain easily recognizable signs which may guide us in distinguishing the different epochs of development.

"Children of wholly different developmental abilities are now taught by the same educational process. This is absurd and should be stopped.

"Every scientific study of children (particularly of those from 10 to 15 years of age) must contain reference to physiological age, and no scientific study is complete without such reference."

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STATEMENT OF C. WARD CRAMPTON, M.D., 1944:

With twenty years in health education and twenty-four more in the practice of medicine, the author has the good fortune to see and consider the end results of the educational process. He meets his high school pupils in high places and low after forty years.

He has watched the educational system with its movements of thought and practice, with both rejoicing and doubt; and has endeavored to aid adolescent interests. He helped organize the Boy Scouts, and has written a page on physical and total fitness for Boys Life for nearly a decade, has written an even dozen books on the subject, campaigned for health examinations and preventive medicine, organized and directed health service clinics and served on many commissions, committees, etc., etc., etc. In and out of season, he has watched, studied, taught, and directed work in this field, and as a physician has medically trained and coached men in living and has sought ways to mend damaged lives as they wax and wane by the decades. He centered much of his attention upon the adolescent, believing that more good or harm can be done in shortest time with less expending of labor and heart's devotion than at any other similar period between birth and death, with which the author is also familiar.

The author's interest lies much in decrescence and the amelioration of the aging process. In this, physiological age is even more important. "Bis pueri senes."

It is an unusual and much appreciated privilege accorded to the writer by our Editors to review some of his early and very earnest efforts to make clear physiological age and its importance.

He is commonly given credit for originating the term, "physiological age." This, I believe, properly belongs to the much respected and beloved Franz Boas, who, with G. Stanley Hall and Luther H. Gulick, gave the author the encouragement of their approval and interest.

No further recommendations are made. The record speaks for itself. It will not, cannot be changed. Today and tomorrow are still before us. Let us see what we can do. Deo juvante.

A STUDY OF THE GROWTH OF THE DYNAMIC CONCEPT OF KNOWLEDGE

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For the careful scientific investigator the conception that knowledge is not exact and static but approximate and changing does not require a lengthy explanation. Knowledge has its source in observations or measurements having greater or lesser variability. If repeated determinations are made at any given moment of the diameter of a cylinder, the strength of an electric current, or the reading ability of a child, it is well known that the successive measures will show some unreliability. That is, they will not duplicate each other exactly but will show a variability. Our knowledge of the diameter of the cylinder, the strength of the current, or the reading ability of the child, consists at its best of an average and its variation.

It is significant to note that the magnitude of the variability determines the extent to which we can predict the probable result when knowledge is used in planning a course of action. If the cylinder is to be supplied with a piston both cylinder and piston are machined to specified tolerances and then "fitted." It is recognized that measurements can be made only within limits and that one cannot predict exactly how the individual pieces will fit.

The relation of the approximate character of measures to the probable error in the predictions derived from those measures has been recognized in such fields as practical mechanics, and some of the more theoretical natural science fields. It has not been recognized, however, in the social area, especially in applied human and social relations. And it is in the social area that this problem is so important. For example, in the present state of knowledge there appears to be some relationship in young children between diet and tooth decay. It also appears that factors other than diet are involved in the production of caries. But what these factors are is not definitely known. An important one may be fluorine. But the relationships in the present state of our knowledge are not clear. If the parent wishes to produce good teeth in his children he cannot logically expect that careful control of diet will certainly assure that the child will have perfect teeth when he makes his first visit to the dentist. Neither can the dentist assume that be-

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cause the child has many imperfections or cavities that the parent has neglected dietary principles. The parent may have been neglectful but before one can infer this from the conditions of the child's teeth the probable errors of the data expressing the relation of frequency and extent of caries to the food eaten must be considerably reduced.

Many of the data used in our everyday planning are based on observations rather than highly refined measurements. It is under such conditions that relatively large probable errors in plans must be anticipated and allowed for. How accurately, for example, can we predict whether a given method of organizing a community will have the results we desire, how many years it will take to pay off a mortgage on a farm, or how effective a given form of industrial organization will be? Yet in all of these, predictions are attempted almost daily.

The problem is further complicated. In almost any field, and in the social sciences particularly, the magnitude of the probable errors may vary rather widely from one portion of a field to another. At a given moment a field of knowledge may consist of some data (or generalizations derived from the data) having a relatively small probable error, and some having large probable errors. In addition there may be hypotheses, that is, statements of relationships that have not been tested.

The trained scientific investigator is also aware that changes in knowledge take place. Hypotheses may be subjected to test and changed into generalizations of known probable errors. More precise measuring instruments may be developed or more complete control of conditions may be achieved with the result that relatively unreliable generalizations are replaced by generalizations having a small probable error and so on. It is important to know that these changes may affect any or all portions of a field. They may be of all magnitudes. They may take place at all speeds.

Knowledge thus presents both a probability and a changing characteristic. Viewed at a given moment there is variability in measurement; viewed over a period of time there is change in degree of refinement.* To use knowledge in planning a course of action requires corresponding flexible and adaptive modes of behavior.

*These statements characterize knowledge as it has been developed. It does not take a position with respect to the philosophical problem as to whether there are exact laws. We may speculate whether there are such laws or not, but the only measurements that the race has been able to devise have some unreliability and the tests of any law are therefore only approximate.

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In contrast to this requirement it may be noted that in our culture preference is given to relatively inflexible "rules of thumb." Man attempts to plan and control his world, especially his social world, by fixed regulations. There are traditions, codes, mores, laws. In all of these there is little that bears any resemblance to an adaptive interpretation or that takes account of the approximate and changing characteristics of knowledge.

The importance of such a dynamic conception of knowledge in the adaption to everyday problems has been suggested in papers by Ojemann (2), and Musgrove (1). There is strong reason to believe that possessing a working knowledge of the concept as it applies in human relations may help in resolving potential conflicts in the workaday world and thus influence development, especially the development of youth and adults. Fundamental to the studies of the role of the concept in human behavior, however, are methods of measurement and methods for controlling its development. The purpose of this paper is to report the results of a test designed to measure the various aspects of the concept in adolescents and to explore the relations between test scores and several variables that may affect its development.

The construction of the test presented a two-fold problem. On the one hand the concept itself may be subdivided into several aspects. On the other, the concept may be applied to all of the various fields of knowledge such as the physical sciences, the social area, the physiological field, etc. Conceivably in a given individual it may be well developed in some areas and not in others. For a thoroughgoing study the several aspects of the concept as they may be applied to the several different fields should be represented in the test.

In this study the concept was subdivided as indicated in Table 1, and items were constructed to cover the applications to physical, physiological, and mental-social areas. The figures in the table indicate the number of test items allotted to each subdivision of the concept and to each area. Even numbers are used throughout so that the test can be divided into two halves for studies of reliability. The total number of items comprising the test is 32.

Some examples of test items may be interesting and helpful to show the nature of the test.

To test the awareness of variability in measures:

Two men were measuring the strength of grip of a class of 8th grade pupils. Each pupil had three trials on each of two

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TABLE 1

COMPOSITION OF TEST

Division of Concept	Area		
	Physical	Physiological	Mental-social
I. The Probability Characteristic			
a. Awareness of probable error of measures	2	2	2
b. Relation of error in prediction to error in fundamental data	2	2	2
II. Growth Characteristic			
a. Awareness of growth of knowledge	2	2	2
b. Understanding of method of growth			
1. Ineffectiveness of factors extraneous to research such as sheer lapse of time and individual prestige	2	4	2
2. Nature and function of research	6*		

* The six questions relating to research did not apply to any one area but rather to all areas.

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successive days. Each time the person who read the scale was behind a screen so that he did not see the children. The conditions were about the same both days. For some of the children the average one day was as much as 2 lbs. higher than the day before and for several others the average was as much as 2 lbs. lower. Do you think:

- (1) examiners can always read the scale exactly right but the children's strength of grip isn't always the same?
- (2) some difference should be expected from one day to the next?
- (3) they didn't get good measurements of those who weren't the same both days?
- (4) they got exact measurements for those who were the same both days.
- (5) the children were the same both days but the examiners read the scale wrong?

To test the awareness of error in predictions:

A man who found it necessary to budget his money carefully had kept a record for the past three years of how much it had cost him to heat his house during each one-year period. He also asked several of his friends who had similar homes how much it had cost them. In making an estimate of how much it will cost him during the coming year it would be most helpful to:

- (1) take the average cost of the last three years of his home and allow for 15 per cent or more either way.
- (2) average the cost for the past years from the different homes and plan on spending just that much.
- (3) average the costs for his home only and allow just about that much.
- (4) take the highest figure for the last three years of his home only and add 10 per cent for increase in price of coal which most people predicted to this man and then be absolutely sure of having allowed enough.
- (5) average the cost of the last three years and allow just about 10 per cent more for any increase in price of coal.

To test the awareness of the growth of knowledge:

A father of two children aged one and three years read a very interesting book on astronomy. The book told in a simple and interesting way how our stars came to be, how the sun gets its heat and how old the earth is. Since this book is easy to read and understand, the father thinks it would be a good book

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to keep so that he can have it for his children when they are about ten or twelve years of age. What do you think of the father's plan?

- (1) It is a good idea to be thinking ahead as this father did and the plan of using the book is good.
- (2) His plan isn't a good one because the book will certainly be far out-of-date in seven to nine years from now.
- (3) His plan is a good one. There won't be any changes in a subject as old as astronomy.
- (4) There may be a few changes in our knowledge of astronomy but all of the most important facts are known.
- (5) There may be changes in a subject as old as astronomy and the father should think of this in his plan.

The 32 items were divided into two groups with the items in each set arranged in random order. The two sets were administered about a week apart. The subjects were 176 juniors and seniors in two midwest high schools.

A scoring key was prepared by administering the test to four persons who obviously possessed the knowledge implied in the concept and using only items to which all four agreed as to the responses. The test scores were then studied as to reliability and the relation of the growth of the concept to such variables as the number of science and mathematics subjects taken in school.

Since the two halves of the test were administered at two different times a reliability coefficient may be obtained by correlating the two separate sets of scores. Reliability can also be tested by correlating chance halves of each administration. These coefficients after the application of the Spearman-Brown formula varied from .72 - .79. A detailed study of the behavior of various items in the test indicates that by covering several aspects of the concept more comprehensively the reliability can be materially raised so that individual scores of relatively high reliability will be obtained. In this paper only group results will be reported.

One of the first questions in which the reader may be interested is that of the magnitude of the score achieved by high school juniors and seniors on a test of this kind. To what extent do they have a functional knowledge of this concept as measured by their ability to apply it to everyday problems. The mean score for the 176 subjects was $18.36 \pm .41$ and the range extended from 6 to 33. The mean score is approximately 50 per cent of the total possible score. When these results are viewed in the light of the fact that the test consisted of relatively simple applications to everyday problems it becomes clear that

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a functional understanding of the concept is not developed to a very high degree in this group.

The reader may also be interested in the correlation of scores on this test with measures of intelligence. Intelligence test scores were available for 147 of the 176 subjects. Eighty-eight of these were Kuhlman-Anderson group test scores and the remaining 59, Otis scores. The correlation of test scores with I.Q. was $.42 \pm .07$. Apparently the test does not measure to a very high degree that which is ordinarily measured by group intelligence tests.

It is also interesting to inquire how the development of the concept compares for the various areas, namely the physical, physiological, and mental-social fields. To make such a comparison it is necessary to express the scores in terms of per cent of total possible score since there is a slight difference in the number of items among the areas. The mean scores expressed in per cent of total possible score are as follows:

Physical area	43.4 ± 1.81
Physiological area	61.4 ± 1.39
Mental-Social area	43.8 ± 1.55

The difference between the scores for the physiological and physical areas as well as that between the physiological and mental-social areas is significant beyond the 1 per cent level. Just why this group of high school pupils should be more aware of the probability characteristics of knowledge in the physiological areas than in the mental-social or physical areas is not clear. An analysis of the test items does not give any reason to believe that the applications in the mental-social and physical areas were of a more abstract nature and there is, therefore, no a priori reason why one would expect a significantly higher score when applications are made to physiological problems. This point awaits further investigation.

The most interesting question, however, is the effect on the development of the concept of various educational experiences such as the nature and amount of training in mathematics and the number of semesters of science. The number of semesters of science taken by the subjects varied from zero to seven. Although the number of categories on this continuum is slightly limited, nevertheless it seemed more helpful to use coefficient correlations in expressing the relation between number of semesters of science and total score. This correlation was $.07 \pm .08$. In other words no relationship between an understanding of the dynamic conception of knowledge as measured by the test and number of semesters of science is indicated.

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The number of semesters of mathematics taken by the subjects ranged from two to seven, but since only one subject had taken seven semesters it was decided to use group comparisons. The subjects were divided into three groups: group one consisting of subjects who had two semesters of mathematics; group two, those having three or four semesters; and group three, those who have had five or more. After the subjects had been divided into the three groups, subjects from one group were matched with subjects from each of the other groups according to sex, grade in school, school attended, and I.Q. The detailed data are given in Table 2.

TABLE 2

SIGNIFICANCE OF DIFFERENCES BETWEEN TOTAL SCORES
AND BETWEEN PHYSICAL SCORES FOR PAIRS MATCHED
AS TO I.Q., SEX, GRADE, AND SCHOOL, BUT DIFFERING
IN THE NUMBER OF SEMESTERS OF
MATHEMATICS TAKEN

	Pairs N	d.f.	t	Sig. of diff. (per cent)
Total Score				
2 sem. vs. 5 sem. math.	10	9	.58	55
2 sem. vs. 3-4 sem. math.	31	30	.92	45
3-4 sem. vs. 5 sem. math.	13	12	.83	40
Physical Score				
2 sem. vs. 5 sem. math.	10	9	1.84	10
2 sem. vs. 3-4 sem. math.	31	30	.25	80

It will be seen that none of the differences is significant.

When the matched pairs were used to determine difference in scores on the physical area of the test the values of "t" were also insignificant. The data are given in the last two lines of Table 2.

Of the two variables studied, namely, number of semesters of science and number of semesters of mathematics, no relationship exists between these variables and test scores. These findings are significant. An understanding of the probability and growth characteristics of knowledge has important applications to everyday problems, nevertheless, the kind of training received by the adolescents at the present time in the areas most likely to influence the development of this concept seems to be relatively ineffective.

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In this paper the results obtained in an analysis of the growth of the dynamic conception of knowledge for a group of 176 high school juniors and seniors are presented. A test for measuring various aspects of the concept as it applies to physical, physiological, and mental-social problems is described. The reliability coefficient obtained by several methods varied from .72 to .79.

This group of high school juniors and seniors obtained a score in the neighborhood of 50 per cent of the total possible score. Since the test items were constructed by using everyday situations it is apparent that the development of the concept had not proceeded very far in this group.

When the applications of the concept to the three areas, physical, physiological, and mental-social were compared, a significantly greater development in applications to the physiological area was found. The physical and mental-social areas were about equal in terms of total possible score, but the development in the physiological area was significantly higher. The cause for this difference is not at present apparent.

The amount of training in courses that might be expected to influence the development of this concept, namely, the number of semesters of science and number of semesters of mathematics, did not yield significant correlations. The correlation coefficient between number of semesters of science and total score was $.07 \pm .08$. Matched pairs yielded no significant differences when compared in terms of number of semesters of mathematics taken.

Since the number of subjects achieving 75 per cent or more of a total possible score is very small, the next step in this series of investigations seems to be to develop experiences which will accelerate the development of the concept so as to make possible studies of the effect of the concept on behavior and personality development.

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SEX DIFFERENCES IN SOCIAL SUCCESS AND PERSONALITY TRAITS

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Sex differences have been the subject of many psychological investigations. Most of the earlier studies were concerned with sex differences in intelligence, academic achievement, and interests. During recent years more attention has been paid to differences in social success and personal traits. The present study is concerned with problems in these areas. The data reported are concerned with answering the following questions:

1. Are there significant sex differences in popularity as determined by pupil choices?
2. Are there significant sex differences in pupil choices of best friends and best leaders for the school year?
3. Are there significant sex differences in twenty personal traits as determined by composite scores based on pupil and teacher ratings combined?
4. Are there significant sex differences in personal traits between most popular boys and most popular girls?
5. Are there significant sex differences in twenty personal traits on the basis of teacher ratings alone?
6. Are there significant sex differences in self ratings on the California Test of Personality?

The subjects used were pupils in three fourth grades in three schools in Denton, Texas. One of the schools utilized is the Demonstration School associated with North Texas State Teachers College; the other two are public schools. All data were collected during the school year 1941-42.

It will be appropriate first to describe the methods of gathering the data.

As stated above, popularity or social acceptance was determined by pupil choices. The choosing situations used in

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the three schools for this purpose are listed below:

In the Demonstration School:

- October, choosing ones preferred as working companions on committees which were to be appointed for the semester.
- December, listing names of all those to whom Christmas presents would be given if it were possible to do so.
- February, listing names of those to whom Valentines were to be given, in order that the teacher would know how many sheets of colored paper to give to each child for making the Valentines.
- March, names of three friends were written on rating sheets which were then used to rate the friends on twenty personal traits.
- April, selecting companions for making an arithmetic chart, and also for working on a sign reading project.
- May, listing names of all best friends throughout the school year, as well as the names of all the best leaders in the room during the school year.

In the Sam Houston School:

- November, listing names of all children who would be selected to remain in the room if all others had to leave.
- December, designating names of those to whom Christmas presents were to be given, as well as names of those to whom presents would be given if it were possible to do so.
- February 10, voting on the king and queen for a Valentine party.
- February 14, determining the number of Valentines each child received. This was done by taking the Valentines out of the box and counting the number for each child before they were distributed to the children.
- March, same as for School A.
- May, same as for School A for both friends and leaders.

In the Robert E. Lee School:

- November, voting for officers in a class club.
- December, same as for November, with all officers available for re-election.
- February, counting of Valentines as in School B.

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March, same as in Schools A and B.

April, election of club officers.

May, voting on the "best citizen" in the room for the school year. Considerable emphasis had been given to citizenship and five or six votings had been held throughout the year on the "best citizen."

Same as for Schools A and B for both friends and leaders.

In nearly all of the above situations there was no limit placed on the number of choices which could be made. This technique provides a more adequate measure of each child's social acceptance than is possible when choices are limited to only one, two, or three names. All the choosing situations were conducted by the classroom teacher.

In order to state general social acceptance or popularity in numerical terms the following system of scoring was used: first choice - 5 points, second - 4 points, third - 3 points, fourth - 2 points, fifth - 1 point, and all other choices - 1 point. (This point system was not used in the situation involving the giving of Valentines, since no order of choice was indicated. Each Valentine counted two points.) The composite social acceptance score for each child was determined by converting his raw score in each choosing situation into a per cent, adding all his per cent scores, and then obtaining an average for each child. For example, one child in Demonstration School received the following series of per cent scores in the eight choosing situations throughout the school year: 4.5, 1.3, 6, 1, .8, 2.2, 4.9, and 8.9. This makes a total of 29.6. When this number was divided by eight, an average of 3.7 was obtained. This was the child's final social acceptance score for the year. All the other children had similar scores which ranged from .37 to 12. The total scores for the children in the other two grades were obtained in the same manner, and since all scores were turned to per cents, the results for the three schools could be thrown together and subdivided into quartiles for comparative purposes.

The California Test of Personality - Elementary, Form A was administered to the children in the month of March, 1942. The children had no difficulty in answering the questions, with the exception of those who were very poor readers. These had to be helped individually by reading the questions to them.

The scale used to obtain the trait ratings was a slight modification of the scale developed by Caroline McCann Tryon in connection with the Growth Study of Adolescents of the University of California Institute of Child Welfare (13). Some changes were made in the wording in order to make the descriptions of the traits more suitable for fourth grade children. The

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scale is composed of twenty traits each of which is paired with its opposite. Also each is accompanied by a sub-statement which makes its meaning more clear. Below are three examples taken for the scale.

Is Like This:	About Average	Is Like This:
<u>Restless</u> : finds it hard to sit still in class; and he moves around in his seat or gets up and walks around.		<u>Quiet</u> : can work very quietly without moving around in his seat.
Is Like This:	About Average	Is Like This:
<u>Fights</u> : enjoys a fight.		<u>Avoids Fights</u> : never fights but lets the other person have his own way.
Is Like This:	About Average	Is Like This:
<u>Enthusiastic</u> : always seems to have a good time; seems to enjoy everything everybody does no matter where it is - in school, on the playground, at a party, everywhere		<u>Listless</u> : never seems to have a good time; never seems to enjoy very much anything he does.

Since all the other traits are listed in subsequent tables they need not be given at this point.

The children had no difficulty in following this scale with the exception again of those who were very poor readers. Individual help was given to these as in the case of those who could not read the Personality Test.

All the children were given three copies of the scale and were told to rate three other pupils whom they regarded as friends in their room at school. Since children vary greatly in popularity, some were rated by eight or nine other pupils, and in one case by eleven others. Also a few children were not rated at all, since no one chose them as friends. In order to get ratings on all children, the names of those who received no

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ratings, or only one or two, were written on copies of the scale, and these were distributed to the pupils in each room with the direction to make the ratings as best they could. Some attempt was made to have a child rated by another one whom the teacher considered to be his friend, but in many cases this was not possible. However, the fact that the two children were not personal friends probably should not be considered a serious matter in the validity of the ratings, since in almost every case both children had been together in the same grade for more than one semester and in most cases for more than three years. No child was included in the ratings who had been in the group less than six weeks. Furthermore, not more than 20 per cent of the children in any grade were involved in the assigned ratings.

After the children had completed their ratings, each of the classroom teachers rated all their pupils on the same scale. The teachers did not know how the children had rated each other when they made their own.

After the data from the rating scales were tabulated, a system of scoring was utilized to arrive at a total score for each child. This system was as follows:

Marked degree of given trait	5
Above average of given trait.....	4
Average amount of given trait.....	3
Below average of given trait.....	2
Marked absence of given trait.....	1

These different degrees were defined as follows:

1. **Marked Degree** - Three or more pupils agreed 100 per cent and the teacher agreed with the pupils.
2. **Above Average** - Sixty per cent or more of the pupils (but not 100 per cent) agreed and the teacher agreed with the pupils; three or more pupil raters agreed 100 per cent but the teacher disagreed, or rated the child as average.
3. **Average** - The pupils were divided (anything less than 100 per cent agreement) and the teacher rated the child as average, or disagreed with the predominant rating of the pupils.
4. **Below Average** - Same standards as for "above average" except for opposite trait in each pair.
5. **Marked Absence** - Same standard as for "marked degree" except for opposite trait in each pair.

In those instances in which the pupil raters were evenly divided, the scales were tipped in the direction of the teacher's

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rating.

Although the most typical number of child raters for each pupil was three, better than a third of the population in each grade had four or more pupil ratings upon which their composite score could be based. Approximately 10 per cent had six or more ratings. With this many raters, together with the rating of the teacher, upon which to base the score for each trait, it would seem that the measures obtained should be regarded as having a high degree of validity.

Attention will now be given to the first question of this study: Are there significant sex differences in popularity as determined by pupil choices? The facts bearing on this question are given in Table 1.

TABLE 1
NUMBER AND PER CENT OF BOYS AND GIRLS
REPRESENTED IN QUARTILES BASED ON
SOCIAL ACCEPTANCE SCORES

Quartiles	No. of Boys	Per Cent of Boys	No. of Girls	Per Cent of Girls	Diff. in Favor of Girls
4	9	22.5	13	28	5.5
3	9	22.5	12	26	3.5
2	11	27.5	10	22	-5.5
1	11	27.5	11	24	-3.5

A brief examination of Table 1 reveals that the girls are represented in the two upper quartiles to a greater extent than the boys, and that the opposite is true in the two lower quartiles. The data show that there are 5.5 per cent more of the total number of girls than of boys in the highest popularity quartile. A higher proportion of girls is also found in the third quartile, and, of course, it would naturally follow that the boys have higher proportions in the two groups below average in social acceptance. The question may be asked: Are these differences large enough to be considered significant? Probably a conservative opinion would be that they are not. However, it is necessary to consider more of the data available from the study before making a more thorough evaluation.

In Table 2 the boys and girls are compared as total groups (see next page).

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TABLE 2

SEX DIFFERENCES IN SOCIAL ACCEPTANCE SCORES
BY PUPIL CHOICES

Sexes	No.	Mean	Range	Sigma	σ_m	σ_d	Diff.	C.R.
Boys	40	3.24	10.86-.37	2.67	.42	.60	.57	.95
Girls	46	3.81	12.00-.00	3.06	.44			

A brief study of Table 2 shows that the girls have a slightly higher mean than the boys, and are a little more variable on the basis of both range and standard deviation. However, it can be observed that the critical ratio is far below the standard for statistical reliability. Consequently, it must be concluded that although the girls in the groups studied were slightly superior to the boys in social acceptance, there is very little assurance that this difference would hold true in other similar samples.

The second question of this study bears a close relation to the above data. Are there significant differences between the sexes in pupil choices of best friends and best leaders for the school year? This question is answered in Table 3.

TABLE 3

SEX DIFFERENCES ON CHOICES OF BEST FRIENDS AND
BEST LEADERS FOR SCHOOL YEAR
40 BOYS AND 43 GIRLS

Sexes	Best Friends				Best Leaders			
	Mean	Md.	Per Cent Zero Scores	Range	Mean	Md.	Per Cent Zero Scores	Range
Boys	3.37	2.1	23	0-19	3.57	1.0	35	0-19
Girls	3.68	3.3	16	0-19	3.64	1.1	35	0-17

A number of facts are evident from Table 3. The girls have slightly higher means than the boys for both friends and leaders. (The differences are too small to warrant statistical treatment.) The median for the girls in "best friends" is definitely higher than that for the boys, but there is no difference in medians for "best leaders." The girls have 7 per cent less zero scores

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than the boys in "best friends," but the per cents are the same for "best leaders." The sexes show practically the same range in both measurements.

It is apparent from the above facts that the girls have a slight superiority over the boys in the voting for "best friends," but that there is no sex difference in the voting for "best leaders."

The rather small differences found in this study between the sexes in social success is at variance with results previously published on most of these same subjects when they were in the second and third grades (1, 2). In these earlier grade levels the girls showed a rather marked superiority over boys in both general social acceptance and in number of mutual friends. There is not sufficient data from this study, or from others elsewhere, to know whether there are any typical changes which take place in the relative social success of boys and girls as they pass through the elementary school. The present data are only suggestive of the possibility that boys may attain a better social status as they go beyond the third grade. It is known that girls mature more rapidly than boys and that this rate of maturity slows down with age. This fact might have some bearing on the above findings.

Attention will now be turned to a consideration of sex differences in personality traits. Are there any differences between boys and girls in personal traits which are important to parents and educators? The data of this study bear on this question, first, from the standpoint of the composite scores which were obtained from a combination of pupil and teacher ratings on twenty personal traits. The determination of these scores has been previously described. Table 4 summarizes the trait differences between the sexes.

A review of Table 4 shows that in only two of the twenty traits is there a completely reliable difference between the sexes. These two are "restless" and "fights," and in both traits the boys have the higher scores. There are three other traits, however, which show differences that are almost completely reliable, since the critical ratios are all 2.5 or better. These three are "tidy," "happy," and "at ease with adults." All these differences are in favor of girls. These two sets of results complement each other in emphasizing the energetic, aggressive traits of boys as contrasted with the more quiet, conforming traits of girls.

In order to check further on sex differences in personality, the twenty most popular boys were compared with the twenty most popular girls. In nearly all the traits the differences were very small, but there was a striking corroboration of the results given in Table 3 in that the boys again were shown to have

TABLE 4

AVERAGE SEX DIFFERENCES IN TWENTY PERSONAL TRAITS BASED ON
COMPOSITE SCORES FROM PUPIL AND TEACHER RATINGS

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Sexes	Number	Restless	Talkative	Attention Getting	Bossy	Tidy	Fights	Daring	Leader	Active in Games	Sense of Humor	Friendly	Welcomed	Good Looking	Enthusiastic	Happy	Laughter - Jokes	At Ease with Adults	Active in Recitations	Grownup	Older Friends
Boys	37	2.6	3.0	2.6	2.1	3.8	3.0	3.7	3.0	4.1	3.9	3.9	3.9	3.7	3.8	4.0	3.7	3.4	3.7	3.3	3.8
Girls	42	1.8	2.7	2.4	2.0	4.3	2.1	3.3	3.3	3.9	3.7	4.0	4.0	3.7	4.2	4.4	3.7	3.8	3.8	3.3	3.5
C.R.*		3.5	1.7	1.3	1.0	2.5	3.6	2.0	2.0	1.0	1.5	.7	.7	0	2.0	2.7	0	2.7	.6	0	2.0

* Critical ratios were obtained by dividing the mean differences between the sexes in the twenty traits by the standard error of these differences.

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reliably higher averages in "restless" and "fights." The boys had an average of 2.50 in fighting as compared with only 1.55 for the girls. The critical ratio of the differences was 11. The average for the boys in "fights" was 3.0 as compared with 2.0 for the girls. The critical ratio of the difference was 12.5. These marked differences show that popular boys are much more likely to be characterized by overt activity and aggressiveness than are popular girls. This conclusion is reinforced by the findings from the study of adolescents by Tryon previously cited. Two of the traits found by her to be generally approved for twelve-year-old boys and not approved for twelve-year-old girls were "restless" and "fights" (13, p. 60).

May not the above findings be interpreted to mean that a school in which popular boys feel at home must be one which allows sufficient leeway for energetic activity, social aggressiveness, and even some fighting - at least of a mild sort? Also do not the above findings mean that if boys and girls are to be educated together - and the writer believes that they should be - that some differences should be allowed in the kind of behavior standards expected of the two sexes? Should not parents and teachers encourage boys to be aggressive in socially constructive ways in order to promote their popularity? Should Sunday School teachers teach boys that they should never fight but should, instead, "turn the other cheek?" And what about severe disciplinary control which causes most of the more timid boys to suppress what little aggressiveness they have? Studies on psychological sex differences should be of value to parents and teachers in emphasizing the importance of educating boys to play the most approved masculine role, and of educating girls to play the most approved feminine role in our society.

The fifth question with which this study deals bears closely upon the preceding findings and remarks. This question is: When the teacher ratings on the twenty personal traits are taken separately from those of the pupils' ratings, what sex differences are evident? Do they agree with those from the composite scores? Table 5 gives the teacher ratings.

Table 5 shows only the high positive ratings given by the teachers, that is, checks at the extreme left of the scale. The remaining percentages for each trait were not all at the opposite end of the scale, since there were a good many average ratings. It was thought, however, that these average ratings probably represented a rather high degree of uncertainty on the part of the teachers and therefore would be less significant.

A brief examination of the differences in Table 5 shows that the greatest sex differences, as observed by the teachers, are in the following traits: tidy, fights, good looking, enthusias-

TABLE 5
SEX DIFFERENCES IN TEACHER RATINGS ON TWENTY PERSONALITY TRAITS
(ALL FIGURES IN PER CENTS)

Sexes	Number	Restless	Talkative	Attention Getting	Bossy	Tidy	Fights	Daring	Leader	Active in Games	Sense of Humor	Friendly	Welcomed	Good Looking	Enthusiastic	Happy	Laughter - Jokes	At Ease with Adults	Active in Recitations	Grownup	Older Friends
Boys	37	11	35	16	16	65	24	40	27	65	48	46	46	35	78	56	29	43	43	24	48
Girls	42	12	31	24	16	91	10	39	39	58	53	56	46	51	56	63	42	51	51	46	48
Difference in favor of girls		1	-4	8	0	26	-14	-1	12	-7	5	10	0	16	-22	7	13	8	8	22	0

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tic, and grownup. The percentages are in favor of the girls in the traits of tidy, good looking, and grownup. The first two of these three traits show that the girls are upholding their reputation as the "fair sex." The third is particularly interesting in view of the fact that girls are known to mature more rapidly than boys.

The 14 per cent higher rating for boys in "fights" corroborates the finding on this point from the composite scores given in Table 4. There would seem to be little room for doubt but that this is a true sex difference in the groups studied, and presumably in other similar populations.

The finding in Table 4 that the boys were reliably more restless than girls is not borne out from the teacher ratings alone. It may be that the pupils were in a better position to observe this trait than the teachers, since they were in closer contact with each other.

The 22 per cent higher rating in enthusiasm given to the boys by the teachers is also at variance with the composite scores, since on the latter the girls had a little higher average in this trait. It is possible that this difference is due to enthusiasm being a hard trait to rate, since it is rather broad in its meaning, even with the descriptions given on the scale. It is also possible, however, that the kind of energetic activity which the children viewed as "restlessness" was viewed by the teachers as "enthusiasm."

It is again noteworthy that by and large the differences between the sexes in the twenty personal traits are not great, although it is still true that the girls have an edge over the boys in nearly all traits which have the most direct bearing on success in inter-personal relationships as: tidy, leadership, friendly, good looking, and laughter and joking. Being "welcomed" shows no sex difference.

The final question of this study has to do with sex differences in personal traits as revealed by self-ratings on the California Personality Test. Table 6 gives the findings on this question.

The data of Table 6 reveal the following facts: The girls are superior to the boys in every aspect of the scale except two (C and E), there is an appreciable difference between the sexes in only one trait (social skills), but the differences approach statistical reliability in five other traits, namely, Total Self-Adjustment, Self-Reliance, Sense of Personal Worth, Community Relations, and Total Adjustment. All the critical ratios for these last five measurements are 2 or better.

It is certainly significant that the self ratings are in line with results from the pupil choices in showing that the girls have an edge over the boys in attaining desirable personality

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TABLE 6

SEX DIFFERENCES ON THE CALIFORNIA TEST OF PERSONALITY - ELEMENTARY, FORM A 38 BOYS AND 44 GIRLS

Divisions of the test	Mean		Mean Diff. in Favor of Girls	Sigma		Diff. S d (C.R.)
	Boys	Girls		Boys	Girls	
1. Total Self Adjustment	47.2	56.5	9.3	19.5	20.6	2.07
A. Self Reliance	62.2	72.8	10.6	22.2	23.4	2.00
B. Sense of Personal Worth	54.3	65.8	11.5	28.0	24.4	2.00
C. Sense of Personal Freedom	40.4	40.3	-.1	24.2	18.5	.08
D. Feeling of Belonging	58.4	58.9	.5	28.6	28.0	.08
E. Withdrawing Tendencies (Freedom from)	45.1	44.2	-.9	29.4	31.6	.13
F. Nervous Symptoms (Freedom from)	37.6	47.4	9.8	30.4	28.7	1.50
2. Total Social Adjustment	45.9	53.6	7.7	24.7	26.2	1.40
A. Social Standards	48.1	54.6	6.5	29.4	25.9	1.07
B. Social Skills	47.0	64.0	17.0	23.4	20.8	3.39
C. Anti-Social Tendencies (Freedom from)	47.0	55.8	8.8	26.5	26.9	1.49
D. Family Relations	49.5	61.1	11.6	29.9	30.8	1.73
E. School Relations	42.3	55.0	12.7	29.0	30.0	1.89
F. Community Relations	47.7	65.4	17.7	34.0	27.0	2.60
Total Adjustment	47.1	57.4	10.8	21.2	22.2	2.25

traits and social skills. It is true that many of these differences are small, and even slight in some instances, but still the differences are there with a high degree of consistency.

The two differences in Table 6 which are in favor of boys are too slight to be of any consequence. It is interesting to note, however, the similarity between these two traits and the two found to show the greatest difference between the sexes in

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Table 4, namely, "restless" and "fights." A sense of personal freedom and the absence of withdrawing tendencies bear a close relation to the active and aggressive characteristics of restlessness and fighting.

It is particularly noteworthy that the one trait on the self-rating scale which showed a completely reliable difference of girls over boys was "social skills." Here is testimony from the boys themselves that they feel inadequate in social relationships as compared with girls. Such testimony, especially when corroborated by other sources of evidence, should be taken seriously by parents and educators.

Is it not possible to see a relation between the findings of this study on sex differences in personality traits and certain persistent problems which adults have in managing boys, particularly in institutions such as the church, and the school. It has long been recognized that boys are more difficult to manage than girls. Disciplinary records in schools are proof of this as well as statistics on delinquency which show a much larger proportion of boys over girls. Also teachers generally rate girls as having more favorable personality traits than boys. Some studies have shown that girls make consistently higher grade averages than boys throughout the school system (8, 12). Also more boys drop out of school. The seriousness of this latter fact is noted by Englehardt and Overn in their Secondary Education Principles and Practices (p. 17) when, after reviewing some figures on the relative proportion of the sexes graduating from high schools, they say: "Only as one reflects on the data does the full significance appear. Those responsible for education are confronted with a serious problem when the proportion of boys graduating from high schools is as small as it appears in many of the public schools." It is a matter of common observation that girls stay in churches to a much larger extent than do boys.

Aside from other factors which are known to be operating, is it not possible that one reason why boys drop out of churches, schools, and even homes faster than girls do, is that many of these basic institutions are not well adapted to typical masculine traits. It seems to be true, particularly in respect to schools, that when greater provision is made for the expression of aggressive traits, the boys do stay in school longer and offer much less difficulty in the way of control. Provision for the expression of aggressive traits in schools has been attained chiefly through a more liberal type of administrative control, student participation in school management, athletics, other forms of extra-curricular activities, and the allowance of more student initiative in regular class work. Of course, girls as well as boys

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have participated in all these things, but it seems true, nevertheless, from the studies on sex differences, that such policies and activities are more necessary in the education of boys than of girls. It is interesting to note a corroboration of this point in a study by Landreth on crying among children of nursery school age (9). Although not much difference was found between the sexes in amount of crying at the nursery school, a considerably higher incidence of crying among boys was found in the children's homes. The author concludes that it is possible that boys of the socio-economic group studied "are more irked than girls by complying with routines and parental restrictions of activity." The author refers to Goodenough's findings on negativism in nursery school children as supporting this view.

The small but consistent superiority of girls over boys in scores on the social acceptance tests as well as on the California Personality Test should be a stimulus to parents and teachers to reconsider their programs for the socialization of boys. Although it is true that only on the Social Skills section of the California test was a highly reliable difference obtained, still the consistency of the girls' superiority should not be overlooked. Furthermore, as previously stated, the girls in this follow-up study have shown considerably greater superiority over the boys in social success in the two preceding school years. The possibility of a real sex difference in ease of socialization, as well as in the kind of social control best adapted to promoting personality development, should not be lightly dismissed, any more than it should be accepted without sufficient evidence. Certainly there are many homes, churches, and schools that have made marked progress in the last twenty-five years in making better provision for the needs of both boys and girls, but it is equally certain that many others have not. This is obviously a large problem with many phases to it. The only contribution of the present study to this problem is in emphasizing the need, on the part of adult leaders of children, of being more concerned about developing social skills in boys, and of instituting a type of social control which will allow constructive expression of aggressive traits. When boys do not acquire facility in social skills they feel inferior and are likely to compensate in some socially disapproved ways; when their normal aggressive impulses are denied expression their typical response is either to fight back in some way or to leave the situation - whether it be home, church, or school.

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SUMMARY

Social success in three groups of fourth grade children was determined by pupil choices. Ratings on personal traits were obtained from pupils and teachers. Self-ratings were obtained from the California Test of Personality - Elementary, Form A.

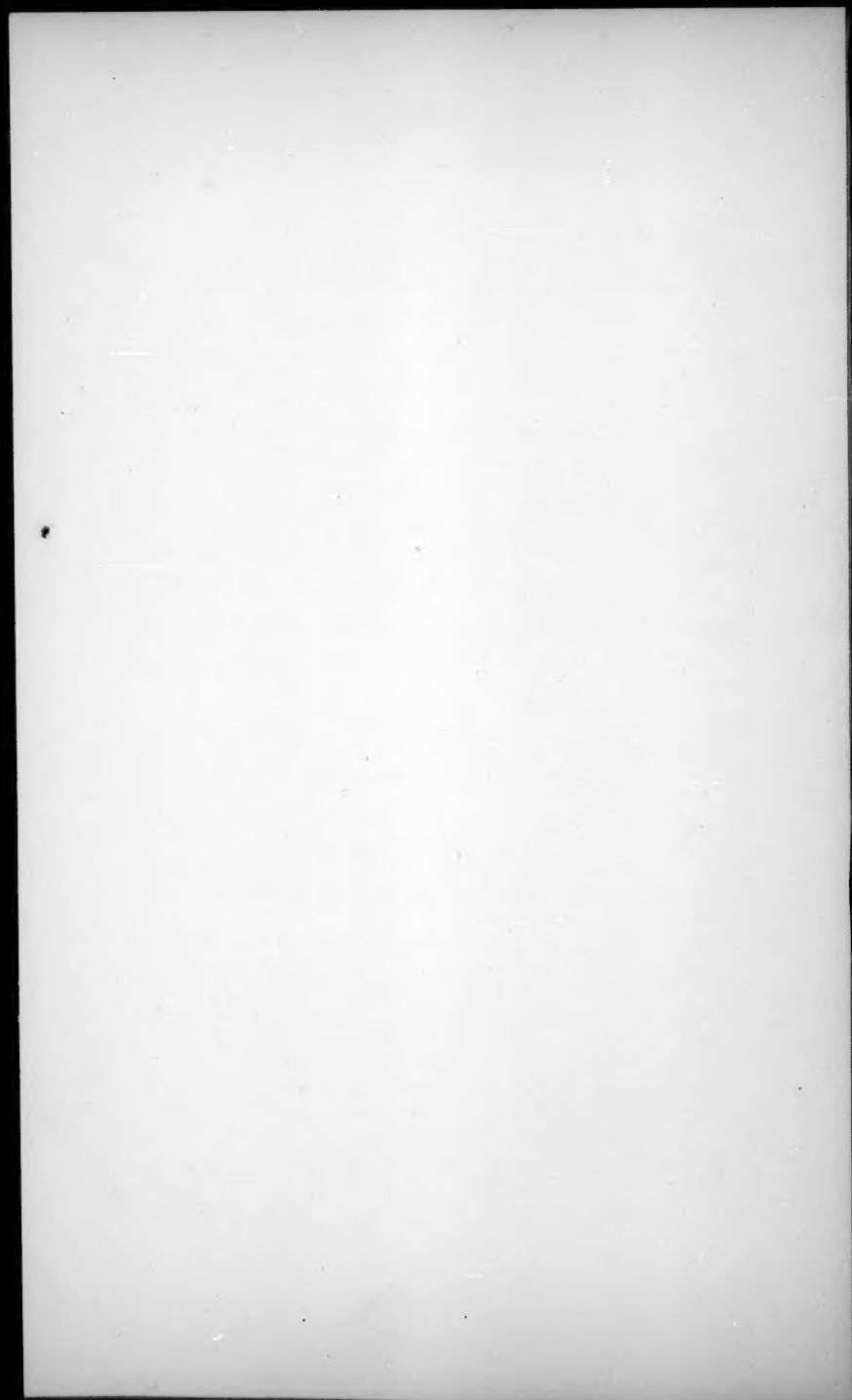
On the whole, sex differences in social success and in personal traits were not found to be large, but there was a high degree of consistency in favor of girls on both kinds of measurements. In only two traits were highly reliable sex differences found. These traits were "restless" and "fights," and the boys had the higher scores. These two traits were also the only ones in which the most popular boys had reliably higher averages than the most popular girls. Also on the basis of teacher ratings taken separately from the pupil ratings, the boys were given a 14 per cent higher average than the girls in "fighting." The teacher ratings gave the girls markedly higher averages in being tidy, good looking, and grownup. On the California Test of Personality the girls had a higher mean score on Total Adjustment and on all subdivisions of the scale except two, but complete statistical reliability was found on only one part of the test. This was on "social skills," and the advantage was with the girls.

Some relationships between these findings and the education of boys and girls were pointed out.

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